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INSECTS' EGGS: THEIR STRUCTURE, VARIETY, AND BEAUTY.

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(*With a Coloured Plate.*)

In our country rambles, some among us may have been tempted to examine what appeared to be curled-up leaves, or patches of whitish dots adhering to branch or stem, many so like the bark of the tree itself, that at a first glimpse, even the practised eye might have failed to detect that they were organised bodies. Upon more closely and attentively scrutinizing these little adhesions, they are seen to be collections of insects' eggs, thus skilfully deposited and concealed with maternal care. To such apparently unimportant objects I would direct the reader's attention, and more particularly to their structure, variety, and beauty, as disclosed by the aid of the microscope. My observations will be mainly confined to the eggs of the Lepidopterous insects, which at this period of the year may be secured in large numbers, for the purpose of making a careful comparison of their formation, watching the development of the germinal vesicle into that of the fully-formed embryo, and noting the transformation of the creeping caterpillar to a thing of wondrous life and beauty, taking its flight among the loveliest of nature's handiworks, and sipping honey from every flower "from morn to dewy eve."

Nearly all insects are oviparous; the few instances in which this is believed not to be the case, are not positive deviations from the general law. The eggs of insects, however, do not often fall under notice, for in consequence of their smallness, they escape observation; and from the scrupulous care taken by the parent to conceal them from the depredations of their numerous enemies, they are not easily discoverable. The situation mostly selected by the female moth, is the leaf or bark of such trees and plants as will serve their young for food. Sometimes, with an instrument provided by Nature for the

purpose, she bores a hole in the bark in which to deposit them. Not infrequently the interior of fruit or grain, or even a dung-heap is selected, and some few commit their store to water, there to await the heat of the summer sun to hatch the brood.

Their defence against cold, and atmospheric changes consist in coating the inside with a varnish-like substance, while the outside is often covered over with a denser material, as portions of vegetable fibre and the hairs or feathers from the body of the insect, which, together with the leaf on which the eggs are laid, form groups of tiny nests. Others form stronger and more durable receptacles. The female cock-roach constructs a strong horny bag, or purse, in which having deposited her eggs, she carefully carries it about with her. The coccus converts her whole body into a shield or covering for her eggs, so thoughtful does she appear for the future safety of her brood. As a general rule, the female insect having deposited her full number of eggs, leaves them to be hatched by the heat of the sun, which may be accomplished in a few days, or not until the following spring, as is the case with the eggs of the silkworm, and all those laid late in the summer or autumn. The number of eggs produced by different species is very varied, some depositing only two, while others, and by far the largest number, lay them by hundreds. The ant is said to lay from thirty to forty thousand in a year. The queen-bee, fifty thousand; but I believe the ordinary number is much below this. The silkworm moth mostly lays about five hundred eggs. The goat-moth, about a thousand, and the tiger-moth some fifteen hundred, arranged with the most uniform and symmetrical order. Insects' eggs bear great extremes of temperature without losing their vitality; want of air and light appear to be far more speedily detrimental in this respect than the extremes of heat or cold. I have exposed silkworm's eggs to severe frosts, and also plunged them into scalding-water, without in the least affecting them, either for good or evil. Several genera of moths with wonderful instinct, cover their eggs with soft vegetable materials; and some, it is asserted, pluck the hair and feathers from their bodies for the same purpose. A writer states, I think, without sustaining the statement by sufficient evidence, that moths use a pair of pincers, placed at one extremity of the body, for plucking out their hairs to cover their eggs; but this would scarcely seem to be needful, since the eggs are nearly always deposited in groups, and securely fastened up in the leaf on which they have been deposited, so that frequently it requires some force to separate the bundle, and expose them to view.

Some of the Coleopterous insects resort to curious and inge-

nious methods of concealing their eggs—for example, the burying-beetle deposits hers in the decaying carcasses of such animals as moles and mice, which they bury, if not already beneath the surface. It is stated by an observer of their operations, that in order to effect this object, several beetles unite their labours and remove the earth from beneath the dead body, which gradually sinks; they then proceed to cover it up, and frequently run backwards and forwards, apparently for the purpose of ramming down the earth. According to an eye-witness of the operations of these grave-diggers, four beetles were observed to inter in a very small space of earth, no fewer than twelve carcasses of various small animals. The object of all this care and solicitude, is not alone the security of their eggs, but to ensure an early supply of food for their young. Another example is afforded from among the *Scarabæidæ*, or larger kind of Dung-chaffers. The earth-borer (*Geotrupes stercorarius*), an insect whose "drowsy hum" falls so often on our ear, during a walk in the country in the stillness of an autumnal evening, digs round holes in the earth, often of considerable depth, then conveys a small quantity of dung to the bottom, in which the eggs are deposited. Each of these is placed in the centre of a small ball or pellet carefully prepared for this purpose; when dry enough, the pellet is transported, it may be to some distance from its place of preparation, to be buried in the hole dug for its reception, and what is somewhat remarkable, when it is unable to raise its load from the ground, it rolls it along, or pushes the pellet backwards with its hind legs. When the surface of the ground is irregular, the labour is proportionably increased, and not unfrequently the beetle is obliged to call in the assistance of its help-mate, before it can overcome the obstacles which impede it. According to some writers, the incessant and arduous labour which these beetles were observed to undergo, led the ancient Egyptians to regard them with a sort of sacred awe, and as symbolical of the labours of Osiris.

In form, colour, character, and beauty of design, the eggs of insects are more surprisingly varied than those of the feathered tribes;* but our acquaintance with the composition of either exterior or interior is certainly not so complete as in the case of birds. The eggs of the animal series differ considerably in their external characteristics, nevertheless, all closely resemble each other, while yet a part of the ovarian ovum. At one period of their formation, all eggs consist of three nearly similar parts. First, The internal nucleated cell or germinal

* The elaboration of structure and variety of forms in a large number of eggs, might be turned to a practical account, as many suggest patterns of great beauty and delicacy for art-designs.

vesicle, with its macula. Second, The vitellus or yolk-substance; and Third, The vesicular envelope or vitelline membrane. The germinal vesicle is first produced, and may be regarded as the ovigerm; the yolk-substance next gradually envelopes it, or is deposited around the germinal vesicle, and the vitelline membrane which encloses the whole, is the latest formed.

The chemical constituents of the ovum is albumen, fatty matters, and a large proportion of a substance precipitable by water. "The production of the chorion or shell-membrane does not take place until the ovum has attained to nearly its full size, and it appears to proceed, in part, from the consolidation over the whole surface of one or more layers of an albuminous fluid secreted from the wall of the oviduct. The observations of Herman Meyer have shown that a part of the outer membrane is also derived from a conversion into it, of the inner cellular or epithelial lining membrane of the oviduct, at the place where it is in closest contact with the surface of the ovum. And many of the varieties in the appearance and structure of the external covering, may probably depend on the different modes of development of these cells."*

The embryo cell appears to be so directly connected with the germinal vesicle, that at a certain period it is absorbed and entirely disappears; or rather, "the germinal yolk becomes the nucleus of the future embryo, when a greater degree of compactness is observed to take place in the yolk, and all that remains of the germinal vesicle is one or more highly refracting fat globules." In insects' eggs, as in those of the higher animals, a clear space is seen between the surface of the yolk-substance and the enclosing vitelline membrane.

The shell is furnished with a lid, to facilitate, it is said, the egress of the mature worm; but since we find that the whole integument offers little resistance to the strong and well formed mandible of the creature, an operculum, or lid, seems to be unnecessary for the purpose stated by continental writers. The chorion, in many instances, is so very thin and translucent, that even the changes taking place within can be readily seen; indeed, I have often watched the young silk-worm eat its way through the chorion, or egg shell, and this its first trial of a formidable cutting instrument, well supplied with muscular apparatus, it uses with admirable dexterity. The head of the young caterpillar, according to the statement of Meissner, lies towards the dot, or central opening in the lid, and which he has termed the micropyle,† from its resemblance

* Dr. Allen Thomson. "Ovum, Cyclopædia of Anatomy and Physiology."

† The term micropyle (a little gate) has heretofore only been used in connection with the vegetable kingdom; it is used to denote the opening, or foramen, towards which the radicle is always pointed.

to a small gate or opening, through which the worm is seen to emerge forth. From a number of observations made on silk-worms' eggs, I have not been able to satisfy myself of the correctness of the particulars described by this observer, nor have I seen the young worm make its way out at this precise spot, but generally at a point much below it. Leuckart states this depression, the micropyle, becomes at a certain period converted into a funnel, which is directly connected with the mouth of the embryo, and serves to convey nourishment from without to it. I see no grounds for such a statement; because in the silkworm's egg, instead of a depression at this point, we have a nipple, and there can be no more necessity for leaving this funnel-shaped opening for the nourishment of the embryo catterpillar, than for that of the chick. There is no opening for such a purpose in the ovum of the bird; indeed the vitelline membrame appears to form a perfectly closed sac to the yolk. In some eggs we appear to have an involuted portion of membrane, indicating simply where either the formative process of the outer membrane terminated, or the spermatozoa passed in to fecundate the yolk mass.*

The germinal vesicle is situated in the yolk mass, it is well marked, and of a very large size, in the egg of the bee, while the egg is yet in the ovasac. By preparing sections, after Dr. Hallifax's method, I find that the germinal vesicle of this insect is not situated immediately near, nor even below, the so-called micropyle, but more to the side of the yolk, represented in Fig. 17, and just in the position which the head of the embryo is found subsequently to occupy towards the end of the period of incubation. The germinal vesicle is well marked; its macula is at first single, then becomes multiple.

The egg membrane, or shell as it is incorrectly called, of the moth and butterfly, is composed of three separate layers; an external slightly raised coat, tough and hard in its character; a middle one of united non-nucleated cells; and an inner one clear, dense, and homogeneous in structure, imparting a fine iridescent glaze to the surface, such as we see and admire in the old glass vessels exhumed from the ruins of Pompeii.

In the silkworm's egg the outer membrane consists of an inner reticulated membrane of non-nucleated cells, and an outer layer, the cells of which are arranged in an irregular circular manner, also non-nucleated, with a number of minute projecting interstitial hairs, or setæ. This layer has probably

* "As to the origin of the micropyle, it does not appear to proceed, as has been supposed by Meissner, from the mere deficiency of the epithelium cells in a certain space, and it is not dependent, either, on its pre-existence in the vitelline membrane, but, according to Leuckart, it is found in the chorion before it appears in the vitelline membrane."—Dr. Allen Thomson.

served, at some time, while the egg was yet a part of the ovarium ovum, as a vascular coat, and being no longer required, has become consolidated to form a part of the dense membranaceous covering.

It is in these several layers of the outer membrane that the micropyle apparatus is situated, and it should be noted that Meissner has described several varieties of the micropyle in the ova of insects belonging to the following genera, viz., *muscæ, tipula, pulex, lampyris, elater, teleophorus, odela, pyralida, tortrix, euprepia, liparis, pieris, panorpa*, and in more than one species of several of these genera. The same author also observed and described in *Musca vomitoria*, a number of spermatic filaments entangled in the micropyle. Leuckart's observations, which are apparently more complete than those of Meissner, differ from his in some particulars; they extend over several hundreds of different kinds of insects' eggs, and he asserts that he succeeded in detecting the existence of the micropyle in not less than 200: he also gives detailed observations on this apparatus, and the structure of the membranes. I willingly admit that such an extended series of observations fully entitles this author to great respect; and when we consider the minuteness of the eggs, and the difficulty of obtaining specimens in a suitable condition for investigations of the kind, we may appreciate the importance of the work, and the amount of labour required to bring such an investigation to a satisfactory conclusion. Leuckart positively asserts that, "in all instances in which the ova were ripe and favourable for examination, he was enabled to assure himself of the presence of the micropyle." This supposed opening will be readily recognised in many of the drawings accompanying this paper, forming, as it does, a prominent spot at the pole of the egg, or in the middle of the circular radiants in the lid.

The outer surface of the egg shell of *Coccus Persicæ* is covered by a series of minute rings, the ends of which somewhat overlap. These rings are believed by Sir John Lubbock to be identical in their character with the whitish substance which exudes through pores on the underside of the body; and it is more than probable that these layers of rings, and their arrangement, account for the beautiful prismatic hues which the egg presents under the microscope, when viewed as opaque objects. This substance, it appears, ultimately becomes a part of the intimate structure of the egg membranes. With regard to the greenish colour of the eggs of *Phryganea*, the same observer states "that it is due to the yolk-globules themselves."* In *Coccus* this is not the case, the yolk-globules are slightly yellow, and the green hue of the egg is owing to

* Phil. Trans. 1859, p. 341.

the green granules, which are only minute oil globules. When, however, the egg arrives at maturity, and the upper chamber has been removed by absorption, these green granules will be found to be replaced by dark green globules, regular in size, and about 1-8000th of an inch in diameter, and which appear to be in no way the same in the yolk of *Phryganea* eggs." Another curious fact has been noticed, which partially bears on the question of colour, the production of parasitic bodies within the eggs of some insects. In the *Coccus*, for instance, parasitic cells of a green colour occur, shaped like a string of sausages, in length about the 1-2000th of an inch, by about the 1-7000th of an inch in breadth. Of the formative process and composition of the colouring matter, not much is known. Valenciennes and Framy, after having bestowed attention on this part of the investigation, selecting the ova of Crustaceans for their purpose, arrived at the conclusion "that it is the same as that existing in the shell; which being green in the moist state, passes into a red colour when solidified." By the aid of alcohol, etc., the colouring matter can be separated and collected in sufficient quantities for spectrum examination. The eggs of moths and butterflies, as I have before stated, present many varying tints of colour, and in speaking of this quality I do not restrict the term solely to the prismatic changes to which allusion has been made, and which are liable to constant mutations, according to the accident of the rays of light thrown upon them, but I more particularly refer to the several natural transitions of colour, the prevailing tints of which are yellow, white, grey, and a light brown. In some eggs the yellow, white, and grey are delicately blended; and these, when viewed with a magnifying power of about fifty diameters, and by the aid of a side-reflector (parabolic reflector), present many beautiful combinations, and the most delicate opalescent, or rather iridescent tints appear on others. The egg of the Mottled-umber moth (*Erannis defoliaria*), Fig. 8, is in every particular very beautiful. It is ovoid, with regular hexagonal reticulations, each corner is studded with a white raised knob or button; the space within the hexagon is finely punctuated, and the play of colours is exquisitely delicate. In this egg I have been unable to make out a micropyle. The Magpie moth (*Abraxas grossularia*), Fig. 1, is another example. The egg is ovoid, and somewhat resembles the former, but does not possess the raised stud or button, at the corner of each hexagon; its colour is very delicate, and silvery in tone. The membrane is so translucent that the movements of the young worm can be very well seen within. The egg of the Thorn moth (*Ennomos erosaria*), Fig. 5, is an elongated square form, one end of which is slightly tapered off, while the other is flattened; in this

the lid is placed, surrounded by a beautifully white-beaded border, having in its slightly raised reticulated centre the micropyle. The empty egg-shell gives a fine opalescent play of colours, while that containing the young worm appears of a brownish yellow colour. The egg of the Straw-belle moth (*Aspilates gilvaria*), Fig. 2, is very delicately tinted; it is somewhat long and narrow in form, with sides slightly flattened or rounded off, and is regularly serrated. The top is convex, and the base a little indented; in the latter is seen the lid and micropyle. The young worm, however, usually makes its way through the upper convex side; the indentation represented in the drawing shows the place of exit. One belonging to a very interesting class of moths, the Dingy-shears (*Exarnis ypsilon*), is shown in Fig. 3. A small sub-conical egg, with a flattened base, which admits of its being firmly cemented to either bark or leaf. The egg is beautifully reticulated, the ribs are slightly raised from the membrane, and connected with each other by cross-bars; they run from a marginal ring surrounding the micropyle, in regular order to the base, and a series of fine lines radiates from the central spot to the border.

An example of those eggs possessing a good deal of natural colour is shown in Fig. 10. The Puss moth (*Cerura vinula*), a large spheroidal shaped egg, having, under the microscope, the appearance of a fine ripe orange; the micropyle exactly corresponds to the depression left in this fruit by the removal of the stalk. The surface of the egg is finely reticulated, or rather has the appearance of a piece of netting stretched tightly over it. The colour is a deep orange. The egg of the Swallow-prominent (*Pheosia dictæa*), Fig. 4, is in shape and size nearly the same as the former. It is spheroidal, slightly flattened at the poles, and, with the exception of one spot, that of the micropyle, the surface is a continued series of regular indentations, reminding one of those fine reticulations, or markings, seen on some of the Guiano shells. The colour is a very delicate pink. There are others rather more decided in their colour, as the egg of the Brimstone moth (*Rumia cralagata*), remarkable for its hexagonal reticulations, it is yellow, spotted with red; that of the Lappet moth (*Gastropacha quercifolia*), with its bluish colour, and three circular bands of brown. The Buff-tiger moth (*Diacrisia russula*), Fig. 7, lays an exquisite little globular egg, the external membrane of which is covered by a fine network of irregular hexagons, which terminate at the pole in a micropyle. It has all the appearance of an iridescent minute glass globule, and is so translucent that the young worm can be seen through it. The Browntail moth (*Euproctis chrysorrhœa*), Fig. 12, produces a small spheroidal egg, which, slightly flattened at the poles, is

uniformly covered with imbricated scales, and is terminated in the upper pole by a geometrical series, which fold in towards the micropyle. In every instance the worm eats its way out of the side of the egg; the aperture is shown in the drawing; this moth appears to cover her eggs with fine hairs, and the empty spherical egg cases are beautifully iridescent. The egg of the small Emerald Volute moth (*Jodis vernaria*), Fig. 16, is remarkable in form, which is somewhat oval, but flattened on the broad side, of silvery whiteness, covered with minute reticulations and dots, peculiarly translucent, so much so that the little yellow-brown worm is seen curled up within, as shown in the egg to the left. At first it appears difficult to detect the presence of either lid or micropyle, and it is not until after the worm has eaten its way out that you clearly see at which end it was placed. The aperture through which it has made its escape is shown in the egg to the right. As to the change of colour (which occurs from physiological causes), connected with the development of the embryo, a remarkable instance is afforded, and one from which the insect partly derives its name, in the Glory of Kent (*Endromus versicolor*). The egg is first bright yellow, then successively green, rose colour, and reddish black. A still more familiar instance is presented in the egg of the Silkworm moth (*Bombyx mori*), Fig. 11, which when first laid is of a delicate pale yellow, this hue it retains for some time, it is subsequently of a reddish brown, and just before the embryo quits the egg it acquires a slate colour, partaking for the time being of the colour of the embryo within; but so soon as the worm emerges forth, the shell regains its original pale yellow. The micropyle, if that can be so called, which in this egg is a raised nipple, is in the more flattened pole of the egg. The mouth of the young worm lies towards the horn of the crescent of that pole, and it is at this point the first cut is made, just sufficient of the membrane is eaten away to admit of the head and body passing through the aperture. The outer and inner portions of the egg membrane are represented magnified 150 diameters at *a* and *b*, Fig. 11.

The egg of the small Silver-lines moth (*Hylophila prasinana*), Fig 9, is yellow brown, in form a truncated pyramid. The micropyle is enclosed in a regular series of radiating lines. A series of raised ribs are set in regular order around the sides, and the cross bars which connect them. These present a pretty basket-like pattern. The egg is flattened out at the base, apparently for the purpose of securing it more firmly to the leaf. The Meadow-brown butterfly (*Epinephile janira*), Fig. 14, lays a sub-conical egg, considerably flattened towards the apex, the raised ribs which stand away from the sides have a silvery colour, and give to the whole a corrugated appearance.

The lid completely occupies the top, and in a smaller inner circle the micropyle is situated. The latter is better displayed when the lid is separated from the egg, as shown at *a*.

The White butterfly (*Pieris brassicæ*), Fig. 13. The shape of the egg is very like the basket employed in lobster fishing, a rarer form than any of the preceding. It is conical, and of considerable length; the lid forms the base, which is slightly recurved upon the sides, and a regular series of ribs with cross bars run from end to end. The eggs are cemented at the base to the back or leaf of the plant in symmetrical order. In colour they are primrose.

The Brown-hair streak butterfly (*Thecla betulæ*), Fig. 15, presents a perfectly white, exquisitely formed, sub-conical egg; at first sight it might be compared to a beautiful ivory-turned ball in miniature. It is covered by a series of deep indentations, or pits, with regularly projecting spines. The pole of this egg dips inward towards the micropyle, forming the funnel-shaped indent spoken of by Leuckart. It is cemented by its broader base to the leaf.

I may remark that the specimens used for illustration were not specially selected, nor are they intended to be type representatives of the eggs of a class of insects which constitute a very large proportion of the most charming denizens of our gardens, fields, and forests. These eggs are taken from a very limited collection, and in no way do they convey an adequate notion of the variety and beauty of objects, wonderfully and curiously fashioned, no two of the species of which are to be found exactly alike. My thanks are due to my friend, Mrs. Maples, for the accurate and beautiful plate which her skilful pencil has enabled me to place before my readers.

The subscribers to the Intellectual Observer will be glad to know that they can obtain most of these eggs from Mr. J. T. Norman, of City Road.

A LIST OF THE ILLUSTRATIONS.

1.—*Abraxas grossularia*, Magpie moth.
2.—*Aspilates gilvaria*, Straw belle.
3.—*Exarnis ypsilon*, the Dingy shears.
4.—*Pheosia dictœa*, Swallow prominent.
5.—*Ennomos erosaria*, Thorn moth.
6.—*Ourapteryx sambucaria*, Swallow tailed.
7.—*Diacrisia russula*, Buff tiger.
8.—*Erannis defoliaria*, Mottled umber.
9.—*Hylophila prasinana*, Silver lines.

10.—*Cerura vinula*, Puss moth.
11.—*Bombyx mori*, Silkworm moth.
12.—*Euproctis chrysorrhœa*, Brown tail.
13.—*Pieris brassicæ*, White butterfly.
14.—*Epinephile janira*, Meadow brown.
15.—*Thecla betulæ*, Brown-hair streak.
16.—*Jodis vernaria*, Small emerald.
17.—Egg of Honey bee, *showing germinal vesicle.*

RAIN.

BY RICHARD A. PROCTOR, B.A., F.R.A.S.

THERE are, perhaps, few natural phenomena which appear less indicative, at first sight, of the operation of nature's giant forces than the downfall of rain. Even the heaviest showers—at least of those we are familiar with in England—are not phenomena which suggest an impression of power. Yet the forces actually called into action before rain can fall, are among the most gigantic experienced on our earth. Compared with them, *terrestrial* gravitation is more feeble than is the puniest infant compared with an array of giants. Let us look into the matter a little closely, and we shall see that this is so.

It is a common occurrence for rain to fall over an area of 100 square miles to a depth of one inch in twenty-four hours. Now, what is the expenditure of power of which such a phenomenon is the equivalent? The downfall is, so to speak, the loosening of the spring, but how much force was expended in winding up the spring? The evaporation from the sea or from moist soils of the quantity of water precipitated, is not the whole of the work to be estimated, since the vapour has to be raised to the higher regions of the air, and to be wafted by the winds—themselves the representatives of giant forces—to the district over which the moisture is discharged in rain. But let us take this evaporation only, and estimate its real force-equivalent. It may be shown by a calculation founded on M. Joule's experiments, that to evaporate a quantity of water sufficient to cover an area of 100 miles to a depth of one inch, would require as much heat as is produced by the combustion of *half a million tons of coals;* and further, that the amount of force of which such a consumption of heat is the equivalent, corresponds to that which would be required to raise a weight of upwards of one thousand millions of tons to a height of one mile! I will run briefly through the calculation by which this last result is deduced from the well-known

result of Joule's experiments that to raise one pound of water one degree Fahrenheit, requires a quantity of heat sufficient to raise one pound to a height of 772 feet; and the further experimental fact, that to raise a pound of water from the liquid to the vaporous state, requires 967 times as much heat as is required to raise the same pound one degree Fahrenheit in heat.

The amount of water required to cover one hundred square miles to a depth of one inch is, in volume—

$$1760 \times 1760 \times 3 \times 3 \times 100 \div 12$$

cubic feet, and as one cubic foot of water weighs 1000 oz., or nearly 63 pounds, we have in weight—

$$1760 \times 1760 \times 3 \times 3 \times 8\tfrac{1}{3} \times 62\tfrac{1}{2} \text{ pounds,}$$

and to raise this weight of water 1° F., would require as much heat as would suffice to raise to a height of *one mile* a weight of

$$1760 \times 3 \times 8\tfrac{1}{3} \times 62\tfrac{1}{2} \times 772 \text{ pounds;}$$

while to vaporize the same weight of water would require 967 times as much heat. Thus we obtain a force sufficient to raise a weight of—

$$1760 \times 3 \times 17 \times 135 \times 193 \times 967 \text{ pounds,}$$

(that is, nearly 1,020,000,000 tons), to the height of one mile.

Such is the amount of force, whose effects are exhibited in a day's steady down-pour over a region of 100 square miles—for instance, over about one-third of Middlesex.

The same amount of water falling in the form of snow, would represent a yet greater expenditure of force. "I have seen," says Tyndall, "the wild stone-avalanches of the Alps, which smoke and thunder down the declivities, with a vehemence almost sufficient to stun the observer. I have also seen snow-flakes descending so softly as not to hurt the fragile spangles of which they were composed; yet to produce, from aqueous vapour, a quantity which a child could carry, of that tender material, demands an exertion of energy competent to gather up the shattered blocks of the largest stone-avalanche I have ever seen, and pitch them to twice the height from which they fell."

But it is when we come to estimate the fall of rain as a terrestrial phenomenon—as a process continually going on over large regions of the earth's surface, as a process in which energies exhibited over one region are expended, frequently, over regions thousands of miles away—that we see the full

significance of the drop of rain. We can well understand how it is that "the clouds drop fatness on the earth," when we estimate the powers expended in their genesis. All the coal which could be raised by man from the earth in thousands of years, would not give out heat enough to produce by evaporation the earth's rain-supply for one single year! The sun—whose influence is often contrasted with that of the rain-shower—is the agent in producing that shower as well as in pouring out his direct heat on the soil with such apparently contrasted effect.

The actual process of the production of rain has not yet been completely explained. We are, in fact, doubtful as to the true nature of clouds, fogs, and mist, and, therefore, it is intelligible that some difficulty should surround the explanation of a phenomenon of which these meteors are, so to speak, the parents.

It is generally supposed that clouds consist mainly of hollow *vesicles* of water, and not of minute drops. Yet meteorologists are far from being agreed on this point. On the one hand we have the evidence of De Saussure and Kratzenstein, who actually saw, or supposed they saw, the constituent vesicles of clouds and fogs. De Saussure, indeed, tells us how we may see the vesicles for ourselves. If a cup of coffee, or of water tinctured with Indian ink be placed in the sun, minute vesicles of various thickness will be seen to ascend from the surface of the liquid. He adds that those vesicles which rise differ so much in appearance from those which fall, that it is impossible to doubt that the former are hollow. Kämtz, also, made measurements of the vesicles of fogs in Central Germany and in Switzerland; and in his valuable work on Meteorology, gives a table and a figure, showing the law according to which the dimensions of the vesicles vary in the course of the year.

Despite this evidence, Sir John Herschel holds a contrary opinion. He points out that the observations of De Saussure and Kratzenstein may be readily referred to the effects of optical illusion. The strongest argument put forward by Kratzenstein is founded on the fact that rainbows are never formed on clouds or fogs, as they would be (according to the undulatory theory of light) if these meteors were composed of globules of water. Sir John Herschel, a higher authority on optical questions than either De Saussure or Kratzenstein, is of opinion, on the contrary, that it is possible a re-examination of the very difficult point in question would give a different account than that usually accepted.

Herschel points out the difficulty of understanding in what manner the condensation of true vapour should result in the formation of a hollow vesicle. Tyndall points out, on the

other hand, a difficulty depending on the state into which water-particles at high elevations sometimes pass. "It is certain," he says, "that they possess, on or after precipitation, the power of building themselves into crystalline forms; they thus bring forces into play which we have hitherto been accustomed to regard as molecular, and which could not be ascribed to the aggregates necessary to form vesicles."

In whatever state the particles of a cloud really exist, it is certain that the fall of rain depends on a process of increased condensation. The causes producing such condensation have been thus summed up by Professor Nichol:—

(1.) The cooling of clouds through the effect of radiation from them;

(2.) The mingling of vapours at different temperatures—a mingling effected by the agency of the winds;

(3.) The rising of vapours towards colder strata of the atmosphere;

(4.) The increase of atmospheric density or pressure;

And (5.) The accumulation and impinging of masses of vapour against some obstacle.

Singularly enough he omits the most important of all known agencies in the production of rain, viz.:—

(6.) The transfer from the equator towards the poles of large masses of moisture-laden air by means of the upper S.W., or counter trade-winds.

I must note also that cause (4) is more than doubtful. Tyndall has shown that rarefaction is an efficient agent in producing the precipitation of vapour. By increase of pressure a larger quantity of moisture is, indeed, compressed within any given space; but, on the other hand, there is an increase of heat within the space which more than counterbalances the former in effect. "The heat developed," says Tyndall, speaking of an experiment illustrating the effects of increased pressure, "is more than sufficient to preserve it" (the moisture added to a given space) "in the state of vapour."

It will be seen at once from the above imperfect enumeration of causes affecting the production of rain, that the phenomenon is no simple one. When we add the variety of circumstances affecting the action of different causes—as the latitude of the place, the elevation above the sea-level; the proximity of the sea; the laws affecting the seasonal variations at the place; the prevailing winds; and the configuration of the surrounding surface, it will become evident that meteorologists may well be perplexed by the very complex set of agencies acting in the production of rain; and so fail—as they have hitherto done—in interpreting any save the most general laws influencing the phenomenon.

Some of these general laws I now proceed to consider.

In the first place, it may be accepted as generally true that the amount of moisture present in the atmosphere is greatest near the equator, and diminishes towards the poles. With the sun's change of declination the zone of greatest moisture passes to the north or to the south of the equator, *following* the sun. The mean region, it is to be noted, is not absolutely coincident with the equator, but some four or five degrees north of that circle. It is easily intelligible that the hottest regions shouldbe, *cæteris paribus*, those over which the amount of moisture present in the atmosphere is greatest, since the heat vapourises the water over these regions. It may not seem, at first sight, quite so obvious that the same regions of greatest heat should also be those in which the rainfall should be in general heaviest. For it might appear that the same heat which produced the evaporation should maintain the water in the state of vapour. The fact, however, that aqueous vapour is lighter than air, operates to produce ascending currents over the region of evaporation, currents strengthened by the expansive effects of the heat. Accordingly, the vapour rises rapidly, and when it has thus risen, many circumstances operate to produce precipitation. First, the upper regions are rarer; secondly, they are colder; thirdly, radiation of heat takes place rapidly from the upper surface of clouds, brought here, as Tyndall expresses it, into the presence of pure space (*dry air* having scarcely any appreciable effect in checking radiation). The result is, that the uplifting of clouds under the sun's influence is followed regularly over the equatorial regions by the precipitation of heavy rain-showers. And *cæteris paribus*, the fall of rain decreases with distance from the equator of heat, though not so regularly as the amount of moisture decreases.

The next great law which presents itself to our consideration is this, that winds blowing towards the equator are, in general, dry winds, and winds blowing from the equator rainy. This law is the direct consequence of the former, but it is necessary, for several reasons, to present it as a separate law. There is an erroneous method of accounting for this law which is very commonly met with in works on meteorology. It is argued that as winds blowing towards the equator are carrying masses of air from colder to warmer regions, they are necessarily dry winds, since, if the air is saturated, or nearly so, at starting, it cannot be saturated when it has become warmer. And *vice versâ*, winds blowing towards the poles are carrying masses of air to colder regions. The air accordingly grows colder, and if not far from being saturated at starting, cannot fail to become unable to keep its whole burden of moisture in the state of vapour, and must accordingly precipitate a portion

as rain. This explanation is insufficient. It would, indeed, be just as reasonable to reverse the argument thus: a wind blowing towards the equator must bring rain; for as it brings cold air into warm regions, if the air in these regions is nearly saturated, the introduction of cold air must lead to the precipitation of a part of the moisture, and *vice versâ*, a wind blowing towards the poles must be a dry, because it is a heat-bearing wind. The simple explanation of the law is, that winds blowing towards the equator are dry, because they are blowing from regions over which moisture is less, to regions over which moisture is more abundant, and *vice versâ*. Of course we must superadd to this the facts mentioned above, because a moist wind blowing towards a heated region would not bring rain with it, and a comparatively dry wind, blowing towards a cold region, might bring rain. But it must not be forgotten that the main question to be considered is the relative moistness of the transported masses of air.

We meet with corresponding laws affecting the rain-producing powers of winds travelling over continents and oceans. A wind blowing over an ocean towards a continent brings rain to the continent, unless the heat over the latter exceeds slightly, or at the least, does not fall short of the heat over the neighbouring ocean. Such a wind is certain to bring rain to an elevated continental region not protected by a mountain barrier yet more elevated. On the other hand, a wind blowing over a continent towards the ocean in general brings no rain.

Lakes, marshes, and rivers, act in a small way a similar part towards the adjoining lands as oceans towards neighbouring continents.

There are circumstances also to be considered as affecting the rainfall in a different manner, viz., not by supplying a greater or less amount of moisture to the atmosphere, but by affecting the power of the atmosphere to keep the moisture it supports in the vaporous state. Such are the *contour* and *elevation* of a country, the nature of its soil, the quantity of forest land, or, wanting this, the relative abundance or paucity of trees, and so on.

A moist and warm current of air impinging on a mountain range, or even on any well-defined rising slope, so as to be carried with sufficient suddenness to colder and rarer regions, is compelled to part with a large portion of its moisture in the form of rain; and conversely a wind which has passed over a mountain range or an elevated plateau, and descends to a lower region, appears as a dry wind, unless that region is one over which a continual process of evaporation sufficient to maintain the air nearly in a state of saturation is going on. In this latter case the effects of the descending wind will vary

with circumstances. It will in general appear as a dry wind, but may produce local showers, since it may act, through the sudden addition of cold air, the part of a condenser.

Forests are great generators of rain. This is mainly due to the peculiar radiative power of trees and vegetables. The soil, where it is covered with vegetation, receives no heat directly from the sun, and but little through contact with the heated air. It may seem like a confusion of cause and effect to speak of vegetation-covered countries as rain-generators, since abundant rain is so important a requisite for the abundant growth of vegetables. This is, however, a case in which cause and effect are interchangeable. Rain encourages vegetation, and vegetation in turn aids in producing a state of the superincumbent atmosphere, which encourages the precipitation of rain. The result is that, apart from external agencies, regions covered with abundant vegetation, and especially with high trees, present year after year, and century after century, a ranker and yet ranker luxuriance of vegetable growth.

On the contrary, arid regions prevent, by their very aridity, and consequently by the intense heat of the soil and superincumbent air, the downfall of the showers which would nourish vegetation. The result is, that even when the soil itself is favourable, it is exceedingly difficult to convert an arid into a vegetation-covered district, the want of moisture being destructive to trees planted in such soils with the object of encouraging rain-falls. The process of change must be a gradual one. On the other hand, the improvement of a region over which rain falls too heavily through overabundant vegetation is a comparatively simple process, a judicious system of clearing invariably leading to the desired result.

The influence of the seasons remains yet to be mentioned among the circumstances affecting the distribution of rain over the earth's surface. The influence of the seasons is different in different zones of the earth's surface. Under the tropics the laws affecting the fall of rain are much more regular than elsewhere. On the ocean we have clear skies where the trade-winds are blowing steadily, and heavy rain falls by day over the intermediate zone of calms; but on the land we have regular dry and wet seasons within the tropics. There is, properly speaking, no winter or summer; but applying these terms to the periods at which winter or summer prevails in the temperate zones of either hemisphere, we may say that the sky is serene in the winter, becomes moist in spring, and the rainy season sets in when the sun is near the zenith. Where there is a considerable interval between the sun's passages of the zenith, as in places not very far from the equator, there are two wet seasons, both occurring in summer. In countries in which monsoons

prevail, however, the alternation of dry and wet seasons depends on the winds. When the south-west monsoon is blowing over India, for instance, there is no rain on the east coast, but abundant rain on the west coast. During the north-east monsoon these conditions are reversed. A little consideration will show that all the above-mentioned seasonal variations within the tropics depend on general laws already stated.

Beyond the tropics there is less regularity. The fall of rain depends on the prevalence of certain winds which bring moisture with them, and these winds not blowing with any regularity, the rainfall is similarly irregular. In countries close to the tropics, there is a noteworthy dryness in summer; for this reason clearly, that in summer the trades blow over these regions, and bring with them "trade-wind weather." Further north, however, though there may be a tendency to the prevalence of north-easterly winds in summer, this tendency is not so marked as to produce a considerable defect of rain in the summer as compared with the winter months.*

In England we have one cause affecting the rainfall which is worthy of special notice. I refer to the Gulf-stream. The air above this warm stream is not only warmer than the surrounding air, but is heavily laden with moisture. When the western and south-western winds loaded with the vapour of water begin to blow over England, they precipitate their moisture in rain as they encounter the colder air over the land; but the manner in which this happens is variable with the seasons, for in the winter months the moisture-laden winds blow lower, and therefore precipitate their vapour earlier; whereas in summer the clouds range higher, and therefore travel farther inland before they fall in rain. The same effects are observable in the Scandinavian peninsula, Norway receiving more rain in winter than in summer; while Sweden, on the eastern side of the Dovrefields, receives more rain in summer than in winter.

Such are some of the general laws which affect the downfall of rain in various countries and at different seasons. There is one circumstance involving the action of a yet grander law —about which, however, considerable uncertainty still exists. I refer to the difference observable between the northern and the southern hemispheres. It has been already noted that the mean position of the medial zone of calms and heavy diurnal rainfalls lies some 4° or 5° to the north of the equator. The total annual downfall of rain north of this medial line is

* So far as my own observations extend, I should say that the two features of our climate which may be most certainly depended on—which, be it noted, is not saying much—are, heavy rains in July, generally in the last fortnight, and serene weather during the second week of November.

slightly greater (so far as our present information extends), than the downfall south of the medial line. And, therefore, since the area of the northern region is less than the area of the southern, it is clear that the annual downfall over any northern zone is, in general, considerably heavier than the downfall over the corresponding southern zone. Now, if we remember that the amount of aqueous vapour raised by evaporation over the southern or watery hemisphere must necessarily be much greater than the amount raised over the northern hemisphere, this result will appear a remarkable one. One would expect to find a difference—and a very marked difference—between the two hemispheres; but instead of the excess of rainfall being in favour of the northern hemisphere, one would expect it to have been in favour of the southern.

If we assume with Maury that the north-easterly and south-easterly trade-winds which meet near the equator merge, respectively, into the north-westerly and south-westerly counter-trades; that is, that they cross over to the opposite hemisphere to that in which they were generated, the difficulty seems to vanish. For in this case, the downfall over the northern hemisphere is due to evaporation over the southern hemisphere, and *vice versâ*. Maury adduces other arguments in favour of his theory of an intercrossing of this sort. Sir John Herschel, however, will not listen to Maury's views. He "declines adopting the doctrine recently propounded of a systematic crossing of the south-east and north-east trades at the medial line. In so doing," he is "in no way disturbed by the phenomenon of infusorial dust of South American origin which occasionally falls on the north-east of Africa," and so on. I must confess that the balance of evidence seems to me to lie on Maury's side in this instance.

It may be asked, however, whether there is any occasion to adopt either view as a systematic account of the laws affecting the trades and counter-trades. May not Maury and Herschel be like the two knights who saw opposite sides of the same shield, and who—both right and both wrong—were persuaded, one that the shield was silvern, the other that it was golden.

If we remember that the medial line marks a zone of calm towards which, from either hemisphere, immense masses of moisture-laden air are continually being swept in, why should we arbitrarily assign to the masses of air passing away above from this calm zone, such a law of motion that every particle of air which has originally come from the northern hemisphere shall take one course, and every particle which has come from the southern shall take an opposite one. It appears to me, on

the contrary, that an intermingling (in masses, it may be, but still complete), must take place above, and result in an almost indifferent diffusion of the vapour-laden air northwards and southwards with the returning counter-trades. The fact that the northern trades have a southerly motion as they enter the calm zone (passing here upwards), and *vice versâ*, may lead to a slight preponderance of air (originally) from the northern hemisphere in the north-westerly counter-trade, and *vice versâ*, but by no means (I should think), to anything approaching the systematic intercrossing imagined by Maury. On the other hand, the preponderance might lie the other way, owing to the effects of collision between the northern and southern trades—but without leading to the systematic return of northern air to the northern temperate zone, and of southern air to the southern temperate zone, conceived to take place by Sir J. Herschel.

One of the most remarkable results of observations made upon rain, has been the discovery that the amount of fall at any place diminishes largely as the rain-gauge is raised above the level of the ground. It is not very easy to explain this remarkable fact. The explanation offered by Kämtz is, that a falling drop carries with it the temperature of the upper regions of air, and condenses on its surface the aqueous vapour present throughout the lower strata of the atmosphere, as a decanter of cold water does when brought into a room. And of this explanation Professor Nichol remarks, that "it is not an hypothesis but a rigorous deduction, giving an account of all the facts as yet ascertained in connection with this subject." But unfortunately, the explanation, though it undoubtedly presents a *vera causa*, will not bear the test of "quantitative analysis." Sir John Herschel has gone through the simple calculation required to overthrow the theory, and points out, that if we allow to the cause the full value it can possibly have (a value far exceeding that which can *probably* be attributed to it) we obtain an effect only one-seventeenth part of what is wanted to account for the phenomenon. Sir John points out also that obliquity of fall cannot possibly affect the observed amount of rainfall, and he offers no hypothesis in explanation of the phenomenon, and remarks in conclusion, that "visible cloud rests on the soil at low altitudes above the sea-level but rarely; and from such clouds alone would it seem possible that so large an accession of rain could arise." He refers, however, in a note, to a paper read by Mr. Baxendell to the Literary and Philosophical Society of Manchester on this subject, in which it is inferred that the only way of accounting for the phenomenon lies in the admission of the existence of water "not in the state of true vapour," but already deprived

of its latent caloric, though not affecting the transparency of the air, so that "a shallow stratum of the lower and comparatively clear atmosphere" may "supply as much rain as a densely-clouded and much deeper stratum in the higher regions." Baxendell mentions also the interesting fact, that the drops of water which drip from the upper part of the shaft increase to an extraordinary size in the descent to the bottom.

It appears to me that the well-known phenomenon of rain falling from a clear sky—a rain termed by the French *serein*—has a suggestive bearing on the peculiarity we have been considering. It proves that water may exist, even in drops, in the atmosphere, without appreciably affecting its transparency. And though it may be an uncommon thing for rain to fall without appearing first in the upper regions of air—in the form of cloud, yet it by no means follows that *during a shower* rain might not be falling from the lower as well as from the upper air-strata, without the transparency of the lower strata being much or at all affected. I have noticed, always, that if the eye be directed steadily at the drops of heavily-falling rain, there will be seen flitting, as it were, among them minute specks, which are seen on a closer observation to be small particles of water. Now, it does not appear to me likely that these, or most of them, are produced by the collision of the falling drops—for the paths of two neighbouring drops must be parallel, since the drops are subjected to precisely the same set of influences.

I believe the phenomenon to be one worthy of more careful notice than it has received—in fact, I am not aware that it has been noticed at all. The motions of the particles are themselves interesting—seeming almost as independent of gravitation, wind-currents, or the like, as the motion of a flight of insects would be. It is hardly necessary to observe that if these particles show that rain is being generated in the lower as well as the upper strata of the air, all difficulty in explaining the results of Professor Phillips's observations, vanishes at once.

THE GRAVE-MOUNDS OF DERBYSHIRE, AND THEIR CONTENTS.

BY LLEWELLYNN JEWITT, F.S.A., ETC., ETC.

(*Continued from page* 266.)

THE ROMANO-BRITISH PERIOD.

As I have said earlier on, the greater part of the Grave-mounds of Derbyshire belong to the Celtic period; the intermediate number to the Anglo-Saxon, and by far the least of all to that now under notice, the Romano-British. There is, both in the lowlands of the county, and in the higher or mountainous districts of the Peak, abundant evidence of Roman occupation, and of the arts practised by that people, but very little knowledge indeed is to be gained there as to their funeral customs or their modes of sepulture. Of the *living* Roman and of his avocations, indications are not unfrequently brought to light by the burrowing miner, or by the surface-working agriculturist, but of the *dead* it is rarely indeed that any remains are exhumed.

In Derbyshire the Roman was, it would seem, more of a "bird of passage" (as well as, to some extent, a "bird of prey") than a settler, and the consequence is that no remains —or next to no remains—of villas or of settlements are found, and that where burial has taken place it has not unusually been in the same mound with those of an earlier period. The Ancient Briton raised the mounds over the remains of his own people, and his Roman subjugator, as occasion required, took possession of them, and therein laid his own dead. Thus the same barrow is sometimes found to contain, besides its primary Celtic interment, and others belonging to the same race, later deposits (nearer to the surface or to the side) of the Romano-British or of the Anglo-Saxon periods.

The Roman roads of Derbyshire were many in number, and some of them are of considerable importance. The principal line (as well, most probably, as some of the others) was formed on an old British way; while other roads were constructed by them for the convenience of working, and for greater facility in transporting the produce of, the mines, in which a profitable trade was carried on. The principal road, the Rykneld Street, entered the county from Staffordshire, and

passed over Egginton Heath to *Derventio* (Little Chester, now an outskirt of Derby); from thence to Pentrich (which is believed to have been a station), and so on to *Lutudarum* (Chesterfield), and forward into Yorkshire. From Little Chester several of the roads diverged, and other lines again traversed the Peak district, both in the neighbourhood of Buxton (supposed *Aquæ*) and in other directions; whilst others again from the lead-producing districts centred in Chesterfield. The stations, and supposed stations, in Derbyshire, were at Little Chester, where a vast number of remains have been found; Chesterfield, where also coins, etc., have been discovered; Buxton, where Roman baths have been traced; Brough near Castleton; Melandra Castle, Parwich, and Pentrich. At each of these places remains of the period have been found. Roman coins, fibulæ, pottery, etc., have also been found in various parts of the county, and show that it must have been pretty fully traversed, and indeed occupied, by that people.

In the mining districts of the High Peak, Roman antiquities of one kind or another are being frequently turned up, and some of the lead mines, which exist and are worked at the present day, are proved to have been known to, and worked by, the Romans. This is, perhaps, more particularly the case in the neighbourhoods of Elton, Winster, Youlgreave, Matlock, etc., where even the names of some of the mines—such as the "Portway Mine," for instance—give evidence of their early origin. Pigs of lead of Roman manufacture have at different times been found in Derbyshire, some of which bear inscriptions referring to the station of *Lutudarum* (Chesterfield), to which I have already alluded. One of these inscriptions is:—T. CL. TR. LVT. BR. EX. ARG., and another, IMP. CAES. HADRIANI. AVG. MET. LVT. The finding of these inscribed and other pigs of lead, the number of Roman roads which traversed the mining districts, and the number of coins and other articles which have from time to time been found about the mines, and in their neighbourhood, show that lead must have been produced to some considerable extent, and that a large number of people must have been engaged in the getting of the ore, and in smelting it.

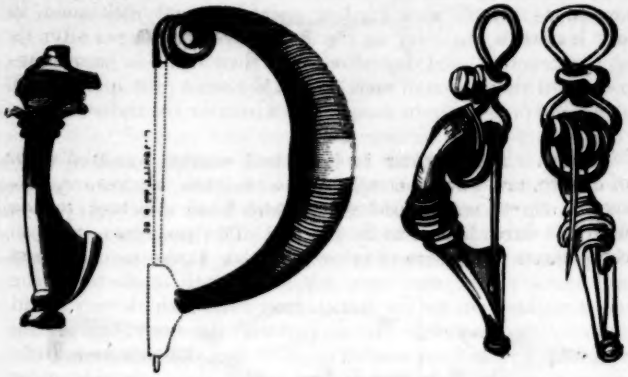
When, in addition to the fact I have stated, that the Roman people did not make regular settlements in Derbyshire, we recal to mind the other fact, that they but seldom raised tumuli over their dead, or, in this country, placed any ostentatious monuments over their remains, the reason is obvious why so few of their sepulchral urns should have been found here, though, doubtless, many urns etc., still lie buried and will yet from time to time be unearthed. It is also necessary to re-

member that the finding of a Roman coin in a barrow is no evidence of that barrow being raised by the Romans, or even of the person interred being of that race. "The Britons, looking upon these tumuli as a kind of sacred ground, continued, in many instances, to bury in the same barrow for ages after its first construction, and deposited with their dead in later times the coins of their Roman masters, on the same principle as that which prompted them in earlier times to inter the rude weapons or ornaments of flint or bone."

The interments which have been discovered exhibit both burial by inhumation and by cremation. Of the former, examples have been brought to light at Little Chester in the course of excavations both for building purposes, and in the formation of the railway works. A skeleton of a man found there some years ago, lay full length on its back, the arms straight down by the sides. Iron rivets, which were found much corroded, lay near various parts of the body, and a thin stratum of ferruginous matter encased the skeleton at a little distance from the body and limbs. From these circumstances it is to be inferred that the deceased was interred in his armour. Other interments by inhumation have recently been discovered in the same neighbourhood, but without, in some instances, the ferruginous appearances. The remains of horses were found along with them. Interments by inhumation have also been found at Brough and at other stations, and, as later deposits, in Celtic barrows. Those where the bones have been found *in situ*, appear, like the one I have spoken of at Little Chester, to have been laid at full length on the back, the arms straight down by the sides. They appear in most instances to have been simply laid in a very shallow grave, but little below the surface of the already formed mound, and to have been then covered to no great thickness with earth. Where interment has been by cremation, the urn, sometimes covered with a small flat stone, containing the burnt bones, has been placed in a small hole dug in the earth, or in a Celtic barrow, and covered over. Not unfrequently domestic vessels have been placed with the cinerary urn, as will be hereafter described.

As the interments of the Romano-British period in Derbyshire are, as I have said, but few, so, naturally, the articles found with them are far from numerous. They embrace, however, pottery and glass, coins, fibulæ, armillæ, and other ornaments of bronze and iron, knives, spear-heads, combs, etc., etc. Of fibulæ, the three examples here engraved will convey a very tolerable idea. The first was found with a Roman interment in a Celtic barrow near Monsal Dale; the centre one was dug up with a quantity of human bones at Little Chester; and

the third one was found at Elton. It is somewhat peculiar in the twisting of the wire at the top. Circular fibulæ have also been



found in the county. Of *armillæ* a very fine pair, here shown, have recently been found at Stony Middleton, about eight feet

below the surface.* They are of base silver and appear to have been much worn. They will be seen to be very similar in pattern to a pair found some few years ago at Castlethorpe, along with a number of Roman coins and other remains, which have been described in the "Archæological Journal."

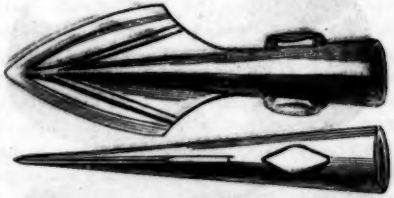
Iron knives have occasionally been found along with human

* Described in the "Reliquary, Quarterly Archæological Journal and Review," for October, 1867.

remains of this period. Instances of this have occurred at Middleton-by-Youlgreave and at Hartington, as well as in other

localities. They appear to have had wooden handles, which, of course, are, except small traces of texture, entirely decayed away. Spear and lance-heads, which have also been interred with the dead, have also been found. Of these, for purposes of comparison with those of other localities, I give two examples.

The first, which is of iron, is from Little Chester, where it was found along with human remains, and the second, which is of



bronze, was found at Hartshay. It is, as will be seen, of somewhat unusual form, and has a loop on either side. Another form, from Wardlow, is also here given. It is of bronze and is 3½ inches long.

Combs and bone pins have been found occasionally with interments of this period.

Coins are, as a matter of course, very generally found with interments of the Roman period both in England and in other countries, and Derbyshire is no exception to the rule. Coins

were buried with the dead in conformity with a superstitious belief that they would expediate the passage of the soul across the lake in Hades. The magic power of money in all connections with human life, originated this custom. In all worldly matters money then was, as it unfortunately now still is, the main, if not the only sure passport to place and honour; and thus it was believed that the soul of the man who had not received the usual rites of burial, and in whose mouth no fee for the ferryman of the Stygian lake had been placed,* would wander hopelessly on its banks, while decent interment and a small brass coin would obviate any disagreeable enquiries that Charon might else be inclined to make as to the merits or claims of the applicant. Thus in the cinerary urns of the period of which I am speaking, coins are very commonly found, and also in interments by inhumation a small coin has in more than one instance in Derbyshire been found within the skull in such a manner as to leave no doubt of its having been placed inside the mouth of the deceased. In some instances a considerable number of coins have been found deposited together, or scattered about in a barrow along with the human remains. In Haddon Field a large number of coins, principally consisting of third brass of Constantine, Constans, Constantius II., Valentinian, Valens, and Gratian, were found along with bones, fragments of pottery, traces of decayed wood, and a portion of a glass vessel. At Minning-Low (the fine chambered tumulus described on page 188, *ante*), where several interments of the Romano-British period have undoubtedly been made in the earlier Celtic mound, many Roman coins along with portions of sepulchral urns, etc., have from time to time been found. These are principally of Claudius Gothicus, Constantine the Great, Constantine junior, Valentinian, and Constantius II. In a barrow near Parwich upwards of eighty coins of the later emperors were found. At Little Chester, some in connection with human remains, and others scattered about in different parts of the station, some hundreds of Roman coins have at various times been found. In my own possession are considerably more than a hundred examples from that locality, ranging from Vespasian to Arcadius, and including Vespasian, Titus, Nerva, Trajan, Hadrian, Antoninus Pius, Faustina senior, Marcus Aurelius, Faustina junior, Commodus, Gordianus III., Philippus senior, Volusian, Gallienus, Salonina, Postumus senior, Victorinus senior, Tetricus senior and junior, Claudius Gothicus, Carausius, Allectus, Constantius Chlorus, Helena, Licinius senior, Constantinus Maximus, Constantinus II., Constans, Constantius II., Family of Constantine, Magnentius, Valens, Arcadius, etc., etc.

* "Nec habet quem porrigat ore trientem."—Juvenal.

In other parts of Derbyshire coins have been found in considerable numbers, sometimes in connection with interments, but more commonly without. Beads have also occasionally been found. The one here engraved was found near to a deposit of burnt bones in a barrow at Harley or Harlow Hill. It is of blue glass, and is of the most usual form of Roman beads.

Of the pottery alone of the Romano-British period, sufficient interesting matter to fill a couple of goodly volumes might easily be written. It will, therefore, be easily understood that in a paper like the one I am now drawing up, which is simply intended to be a descriptive sketch of the contents of Derbyshire grave-mounds, any account of the different kinds of ware made by that people, and of the modes of manufacture which they adopted, would be not only unnecessary, but, to some extent, out of place. Those who desire general information upon the Samian ware, the Durobrivian pottery, and the pottery of the Upchurch marshes, cannot do better than refer to, and study, the three excellent articles on those wares which have already appeared in the pages of THE INTELLECTUAL OBSERVER from the pen of my friend Mr. Thomas Wright, which will be found to give them all the information they can desire. The Roman cinerary urns found in Derbyshire are mostly of the usual globular form, and of a dark bluish-grey colour in fracture. They are somewhat coarse in texture, and are thrown on the wheel. Other varieties, both in form, in colour, and in material, however, occur, as will be seen from the following examples and descriptions. The first engraving exhibits one of the hard bluish-grey vessels I have just now spoken of. When found, it was like the others I am about to notice, filled with burnt bones. The next engravings show two urns containing human remains, the smaller one of which was found at Little Chester. It is formed of a black clay, mixed with small pieces of broken shells—a kind of pottery much used for sepulchral purposes. The larger urn, from my own collection, is of a hard and compact clay, and is beautifully "thrown" on the wheel. These examples are entirely devoid of ornament. The next

example, also from Little Chester, is of a totally different

character. It is of a fine reddish-brown clay, and is ornamented with "slip" in an unusual manner. It measures 3½ inches only in height, and the same in diameter at the mouth. When found, it was filled with burnt bones, among which were some small fragments of

bronze ornaments, which had evidently been burned along with the body. Along with this engraving I give, for the purpose of comparison representations of two other urns from different localities, which will be seen to be of the same general form as the one I have described, although differing from it in ornamentation and in colour of clay.

In the regular cemeteries of the Romano-British period, the cinerary urns were usually surrounded by a group of vessels of various forms, sizes, and uses, which probably had orginally contained wine, unguents, aromatics, etc. Among these, vessels of various makes are found, and occasionally a Samian-ware cup, a patera, or a bowl. Although in Derbyshire no

such regular cemetery has as yet been uncovered, vessels, and fragments of vessels have been found at Little Chester, and other places, along with cinerary urns, which leave no doubt that the usual arrangement obtained in that county, as well as elsewhere. Some of the pottery found appears to be of what is properly described as Romano-Salopian ware—a ware made in Shropshire from its native clays from the valley of the Severn. Examples of Samian ware, too, have been found, but this very seldom, and then only in fragments.

In, at all events, one or two instances of Derbyshire interments, examples of what used to be absurdly called Kimmeridge coal money, but which are, in fact, nothing more or less than the refuse pieces of shale from the lathe of the Roman turner, have been found. Fragments of personal ornaments of the same material have also been discovered.

Enough has now, perhaps, been said to give a general insight into the sepulchral remains of the Romano-British period, as found in Derbyshire. My next chapter will, therefore, be devoted to those of the Anglo-Saxon era.

(To be continued.)

SIR ISAAC NEWTON.

(With a Fac-simile of his Writing.)

BY JOSEPH NEWTON, H.M. MINT.

In introducing the name of the eminent man whose discoveries and deductions in reference to the law of gravitation have recently formed the theme of an exceedingly interesting, and warmly waged controversy, it is not intended to re-open the questions which were at issue between the several controversialists. The reputation, and the merits of Sir Isaac Newton have been ably and successfully defended from the assaults made upon them, and have emerged from the wordy conflict not only untarnished and undiminished, but heightened and enhanced. Were the results, indeed, otherwise, the writer of the present paper would still hesitate before taking part in a discussion which others are so much better qualified than he to sustain. Since, however, the claims of Sir Isaac, as a scientific discoverer have been conclusively established, it may be of interest to inquire into some of his actual works, to demonstrate the practical character of his mind, and to reproduce, as it were, his handwriting and signature, whilst occupying an important post in the State.

For a long series of years the elucidator of the law of gravitation held high office in the Royal Mint of Great Britain, and it is matter of tradition that the establishment in question never had a more assiduous or energetic officer. He was appointed Warden of the money manufactory then existing within the Tower of London, in the year 1695, and in the reign of King William III. This happened to be a remarkable period in the annals of that establishment, for the whole of the monies current in England were then called in and re-coined. In order to defray the expense of the operations, and to cover the loss arising from an immense quantity of counterfeit coin being at the same time taken out of circulation, the device of a window-tax was first employed in this country. Mr. Newton was so successful in his conduct of the important task of remodelling the coinage, that the work was completely effected in the course of four years, and it was admitted that he had, by the introduction of improved mechanical appliances, and of other economical arrangements, saved the country, during that period, no less a sum than £80,000.

His services were duly recognized by the government, and in 1699 Mr. Isaac Newton was gazetted as Master and Worker of the Royal Mint. In the post of Warden his salary and fees amounted to £600 per annum, but as Master they were augmented to about £1,500. From this period forward to the year 1727, when his death took place, Newton continued to fulfil the duties of this latter office. Those duties were complicated to a very considerable extent by the existence of a body of men within the mint, known as the Corporation of Moneyers, and who assumed to themselves, and actually exercised the power, of controlling the executive department of the Mint, independently of the Master. This kind of *imperium in imperio*, as may be imagined, gave great trouble to the supreme governing authority of the establishment. It constituted a state within a state, and it made laws which frequently clashed with those framed by the Master. The Moneyers claimed to be descendants of the oldest officers on record in the Mint, namely, those of Ethelbert, first King of Kent, and who flourished A.D. 561. They stated that the first coin on which the name of a Moneyer appeared was that known as the *sceatta* of Egbert. They traced their pedigree, or their succession, through the Moneyers of the kings of the West Saxons, those of the monarchs of the East Angles, of the kingdom of Mercia, and so on, to the time of William the Conqueror. It was asserted by them that their progenitors were the sole persons mentioned as connected with the Mint, either in the Doomsday-book, or in any of the laws of the Anglo-Saxons. Further, they adduced evidence that the

custom of placing the name of the monarch on the one side of the coin, and that of the chief moneyer on the other, was continued up to the time of Edward I.

Without tracing at greater length the history of this remarkable company,* it may be stated that in Newton's time it consisted of eight members, governed by a senior officer, dignified with the title of Provost, and sundry apprentices. These latter were, up to the year 1827, nominated by the Moneyers themselves, and were usually selected from their own family connexions.†

Mr. Newton was a jealous protector of his own privileges, and gave his orders as to the management of the Mint with great decision and perspicuity. In order to convey an exact idea of the mode in which his wishes were forwarded to the Moneyers, and at the same time to furnish a veritable example of his caligraphy, a fac simile of an instruction given to the Provost of the period, Mr. John Braint, is annexed. The original is endorsed, by the hand of Mr. Braint, as an "Order for Alterin ye edging ye money—1700."

It will be observed that the Master of the Mint has written his order in the most explicit manner, and in that bold but peculiar hand which once seen is not likely to be mistaken. There is no doubt whatever of the genuineness of the document, of which the plate is a most truthful transcript. The original was carefully preserved by the Corporation of Moneyers until 1851, when their charter of power, and their supposed prerogatives ought to die with the mortal of this realm ceased. It was then granted to the owner of the present notice, and in his possession it has remained until now.

It has been stated that Newton was promoted to the post of Master and Worker of the Mint, in 1699; and those who are curious about minute points in connexion with such matters will note that the newly-made officer was very nearly

* The pages of "Ruding's Annals of the British Coinage" are full of information on the point. The Company ceased to exist in 1851.

† Sir Isaac Newton, in the year 1713, attempted to alter this arrangement, and to obtain the power of nominating apprentices himself. He failed, however, in accomplishing that object, and was not even permitted by the then autocratic Corporation to interfere in their selection of apprentices in any way. An entry in the journal of the Company throws a light upon the subject, and illustrates the position of the Moneyers at this time. It runs as follows:—"Some conversation having taken place between Sir Isaac Newton (the Master of the Mint) and the Company of Moneyers, respecting their taking apprentices according to their usual and ancient custom, the following question was put at a full meeting held in their hall on the 4th November, 1713, 'Whether the Master and Worker be asked for permitting the Provost and Company of Moneyers to take apprentices?' Resolved, nem. con., that the Master never had any authority as to the permitting the Provost and Fellows to take apprentices, and that it is not reasonable to ask the Master his consent in the affair, which course might be of ill consequence in the future." Mr. Tierney, Master of the Mint in 1827, first broke this rule, and nominated in that year an apprentice.

Mr Provost

You are to take care that the five pound pieces & forty shillings pieces of Gold & the Crowns & half crowns be made with ANNO REGNI DVODECIMO on the edges till further order

Js. Newton

To Mr John Braint
Provost of the Moniers

Mint Office May 6th
1700.

Fac-simile of Autograph of SIR ISAAC NEWTON,
A Copy of a letter in the possession of Mr JOS: NEWTON.

falling into the error of appending that date, instead of 1700, to the official instruction. Evidently the Master passed his finger over the two figures, 1 and 6, ere the ink with which they were written was dry.

Perhaps Monsieur Chasles may be enabled to institute a comparison between the document now transcribed and those which were said to have been written by the same hand to Pascal?*

It may not be improper to state that the order itself refers to a process of imprinting letters on the edges of coins, which first came into use in the time of the Commonwealth. The impression was given by passing the coin between two plates, one of which was fixed, and the other moveable, by means of a pinion and rack. The half of the legend was engraved on each of these plates, so that when the coin was carried by the moveable plate to the end of the fixed one, it became lettered as desired. The machine used in Newton's time was of this description, and had been invented by a Frenchman, Mons. Caistang.

Newton, who was born on the 25th of December, 1642 (O. S.), at Colsterworth, in Lincolnshire, lived in the reigns of six monarchs and of one Lord Protector. He held the office of Master of the Mint from 1699 to 1727, and therefore under four sovereigns, viz.: William III., Anne, George I., and George II. This statement is sufficient to demonstrate that the posts of Warden, and Master of the Mint, successively held by Newton, were no sinecures. On the accession of each monarch it became necessary to produce new coins of every denomination, and bearing his or her royal image and superscription. Those only who are intimately acquainted with the process of die-engraving, and minting generally, are cognizant of the anxiety and mental and physical labour involved in such changes. They add much to the cares of the responsible officers of the Mint, and demand extreme attention to minute details and minor points of manipulation on the part of subordinates, which is not required when such alterations are completed. For every reason, let us hope that a very long period may

* The French Academy of Sciences is now fully convinced, and freely admits that the Pascal and Newton letters are forgeries, whilst Sir David Brewster has furnished very strong evidence as to the perpetrator of them. From that evidence it seems clear that M. Pierre Desmaizeaux, who resided in England between the years 1692 and 1745, the year of his death, was the author of the whole of the fictitious correspondence. It is known that at Desmaizeaux's death, 120 letters, said to be those of Newton, and 88 letters and notes of Leibnitz, were in the house in which he died. It is highly probable, says Sir David, that Desmaizeaux "spent the last five years of his life in the difficult work of composing the Pascal and Newton correspondence." His family subsequently obtained £500 for the MSS.

elapse before any such transformation is needed in regard to the coinage of these realms!

Previously to Newton's appointment as Warden of the Mint, his sole income is stated to have been derived from his Lucasian professorship, and from the produce of the manor of Woolsthorpe, the combined amount of which, though aided by habits remarkably temperate and abstemious, ill accorded with his natural generosity of disposition, and prevented his relieving the wants of his poor relations.

In proof of Newton's straitened circumstances before receiving the wardenship of the Mint, it may be adduced that there now exists an entry in the "Journal of the Royal Society," dated January 28, 1674—5, whereby he is excused from making the customary payment of one shilling a week, "on account of his low circumstances, as he represented."

Newton received his knighthood in 1705, at the hands of Queen Anne; and at his decease, which took place at Kensington on the 20th March, 1727, he had a personal estate valued at £32,000. At the time of his death Sir Isaac had attained the age of eighty-five. To him may justly be applied the words of the ancient poet:—

"Qui genus humanum ingenio superavit, et omnes,
Restinxit; stellas exortus uti ætherius sol."

FUR-BEARING FOXES.

BY JOHN KEAST LORD, F.Z.S.

About seventy-five thousand fox skins of various kinds are sold at auction annually in London, by the different fur companies. As we contemplate these figures, we may well feel astonished, and fail to understand from whence so many skins are procured, or how it happens that the entire race of foxes escape being utterly exterminated. Nevertheless, wonder as we may, the fact stands before us, that this wholesale destruction of animal life has been continued year after year—we may almost say—since the fur trade commenced in North America, and yet the demand remains at a steady average rate, and the needful supply as constantly arrives to meet it.

Eight varieties of the sub-family *Vulpinæ* are trapped or otherwise destroyed, that their jackets may supply the fur-market—the black or silver fox, the cross, red, white, blue, grey, kitt, and corsac-fox.

It may be as well, perhaps, to state for the benefit of my non-scientific readers, that the family Canidæ includes animals which are characterized by having the jaws somewhat produced, the legs of equal length, the anterior pair being furnished with five toes, and the posterior with four. The claws are non-retractile, and from a remarkable habit all the members of the group have of walking, as it were, on tip-toe, the term *digitigrada* is applied to them. Each fore-foot has a rudimentary toe, to which a claw is generally, although not invariably, affixed. There are two well-marked types of this sub-family *Vulpinæ* inhabiting North America. In the one type represented by the red fox (*Vulpes fulvus*), the tail is uniformly bushy, and is made up of long hairs, which are irregularly mixed in amongst and distributed through a short and rather compact fur. The skull is very wolf-like in character; the temporal crests strongly developed, approach each other, and extend rather beyond the parieto-frontal suture; the muzzle is elongated and particularly sharp. The other type is well exemplified by the grey fox (*V. Virginianus*). An examination of the skull shows us that, in this animal, the temporal crests never approach each other; a space of quite an inch on the parieto-frontal suture separates them. Another marked difference is observable in the shape of the muzzle, which is very short and sharp pointed in this type of fox; and the tail instead of being full and bushy, exhibits, when carefully examined, a regular ridge or mane of bristle-like hairs which extend along its upper line from end to end. These hairs have no short fur intermixed with them, and the longer hair, uniformly clothing the tail, hangs down loosely on each side.

"The following diagnosis clearly describes the points of contrast:—*

"A. Tail with soft fur and long hair, uniformly mixed; muzzle long; temporal crests coming nearly in contact. *Vulpes.*

"B. Tail with a concealed mane of stiff hairs, without any soft fur intermixed; muzzle short; temporal crests always widely separated. A supplementary tubercle on the lower sectorial. The under jaw with an angular emargination below. *Urocyon.*"

Before we proceed to play the spy upon reynard at home in the wilderness, it will not be time mis-spent to consider very briefly the distinguishing characters which separate the wolves (*Lupinæ*) from the true foxes.

If you think it worth the trouble, courteous reader, when you next visit the Zoological Gardens in the Regent's Park, direct your steps towards the cages wherein the wolves are

* Baird, "N. Am. Mam.," p. 121.

confined. Look well at the beast's eyes, the pupils, you observe, are circular; now change the "venu," to employ a legal phrase, and walk into the rodents' house, or visit the den of Arctic foxes, it will do quite as well, and mark the form of the pupillary opening in the eye of the fox; it is elliptical instead of being circular. Here then is one great mark of distinction by which you may easily know a wolf from a fox. The other generic characters may be thus summed up: The wolves have tails somewhat short and inclined to be bristly, and the middle upper incisor teeth are curiously lobed on either side. The foxes' tails are large and bushy, the hairs covering them long and silky; the mane-tailed group form no exception, as the stiff hairs do not in any way detract from the bushy appearance of the tail. The general form of the fox is much more lissome and slender than that of the wolf. In all true wolves the post-orbital process of the frontal bone is markedly convex on its upper surface, rounding off outwards and downwards, and having a well-developed point below the plane of the inter-orbital space; in the fox this bony process scarcely projects at all, and in a few exceptional cases it is even slightly concave; the bony point hardly dips at all, a deep indentation marking the process at the place where it springs from the frontal bone.

It is as well to remark that all the animals of a fox-like type found in South America, occupy a sort of intermediate position betwixt the wolves and foxes proper; indeed they are more nearly allied to the former than to the latter group, as the pupillary opening is circular, and the general form very wolf-like. Burmeister proposes a division of the South American fox-like wolves into two groups, *lycalopex* and *pseudalopex*.

The silver fox, or as it is often styled, the black fox (*Vulpes argentatus*), stands first in our list of fur-bearing foxes as supplying the most valuable fur. An idea may be formed of the money value of the finer skins procured from the silver foxes, when we learn that a single skin has been sold in London for the sum of £100. At the Hudson's Bay Company's London sale, held in March, 1866, silver fox skins, in number 646, realized for the best skins £30 per skin, for inferior qualities, 32s. per skin, which gives an average of £7 9s. 3d. per skin; 646 skins at £7 9s. 3d. per skin = £4820 18s. 6d. I have not been able to find out the prices that silver fox skins realized at the other fur company's sales, which were held about the same time, but I shall be pretty near the truth if I assume that the amounts were equal to those of the Hudson's Bay Company's. The Messrs. Lampson generally offer for sale quite as many silver fox skins as the Hudson's Bay Company, and

often a larger number, and Messrs. Culverwell and Co. would in all likelihood tread very closely upon the heels of the others.

I may mention incidentally, that the Hudson's Bay Company sell their stock of furs by auction in the month of March. These sales are always attended by fur dealers from foreign markets, who purchase such furs as best suit them, and consign them to Leipsig, at which city these furs are again disposed of during the great fair, and thence are distributed to all parts of the world. The other fur companies hold their sales immediately after the Hudson's Bay Company.

Granting I am right in these assumptions, I may safely say that over £14,000 is returned each year at the March fur sales for skins of the silver fox. But it must not be forgotten that this sum only represents the wholesale price; if we take into consideration that these skins are subsequently dressed and made into garments of different kinds by the furriers, and in that condition are retailed at an enormously increased tariff, we shall find that the skins of the silver fox really constitute a most important branch of commerce.

Most of the fox skins purchased at the annual sales are for the supply of the Russian market. Silver fox skins of the finest quality, when dressed, and made into cloaks or other descriptions of wearing apparel for the Russian grandees, sell for sums of money which seem to us almost incredible. A pelisse which belonged to the late Emperor of Russia, was made entirely from the black necks of silver foxes; it may be remembered that this costly garment was displayed at the Exhibition of 1851; its actual money value was three thousand five hundred pounds sterling. Russian taste generally inclines towards dark coloured furs, hence furs which are nearly or quite black, and at the same time of a lustrous, soft, and silky texture, always command the highest prices for the supply of that particular market.

Beautiful silver fox skins are brought from the cold arid districts of North and North West America, nevertheless they will not bear comparison with those obtained from some parts of Russia. There is a popular saying, that these black fox skins of Russian production are worth their weight in gold, an assertion by the way not so far from a truism, when we read that first-rate skins have fetched four hundred roubles each.

As regards the commercial value of its fur, the cross fox (*Vulpes decussatus*) comes next for our consideration. The name cross fox has been bestowed upon this animal because it is distinguished by having a dark coloured cross on its

shoulders. This curious mark is formed by two stripes, one of which extends along the back; in some skins it is quite black, whilst in others it shades off through every gradation of tint, from brown to dingy yellow; the other stripe of a similar tint crosses the back stripe at the shoulders. Skins of the cross fox, when they are very conspicuously marked with either a black or a particularly dark coloured cross, are employed by some religious communities to adorn the vestments of their priests, and extravagantly high prices are frequently paid for skins so coloured, although the market value of cross fox skins is immensely below that of silver. About 3500 cross fox skins are annually disposed of at auction by the London fur companies. I may safely take as a general standard of value for cross fox skins,—a standard quite accurate enough for all practical purposes,—the price paid for these skins at the March sale of 1866, on which occasion the Hudson's Bay Company disposed of 2064 cross foxes at an average rate of £1 14s. 8d. per skin, the highest price being £4, the lowest 14s.; 2064 skins at £1 14s. 8d. per skin = £3577 12s.

The red fox (*Vulpes fulvus*) comes third upon our list of foxes. About thirty-six thousand skins of the red fox are sold each year at the London fur sales, and I shall take the prices red fox skins made, at the March sale of the Hudson's Bay Company for the year 1866, as a fair standard of their average value. The number of red fox skins sold was 13,746, the highest price per skin was 18s. 9d., and 4s. 9d. the lowest; this gives an average for each skin of 10s. 0½d. 13,746 at 10s. 0½d. per skin = £6901 12s.; but we must bear in mind this only represents the sale of one company's furs. To the above number of red fox skins, viz., 13,746, must be added 22,205, as quoted on Messrs. Lampson's catalogue, and 1265 for those of Messrs. Culverwell, Brooks, and Co.—in all 37,214 skins.

Turks are the great consumers of red fox fur, because it is generally employed to line the long cloaks which are so universally worn in Turkey. A very large number of red fox skins are likewise sent to Russia, as well as to the colder parts of Europe, where they are employed for making rugs for carriages and sledges, and as linings for winter garments.

In the trade these three foxes—viz., the silver, cross, and red foxes—are held to be distinct species, but there can be very little, if any, doubt that they are simply varieties of one common type. If a specimen of the black or silver fox is placed beside a red fox, the difference of colour is so marked that one is disposed to say at once that the two animals must be specifically distinct from each other; but when I go to the fur stores and arrange a hundred or more skins side by side,

I find every gradation of colour, placing the cross fox in the centre of the line, from the black at one end to the red at the other, and I defy the keenest and most experienced fur trader to say, in very many instances, to which of the three varieties of fox a skin actually belongs. The red fox, if we admit this opinion to be correct, may be said to have three distinct types of colouration—No. 1, very bright yellowish-red; No. 2, having a dark cross on the shoulders, the prevailing colour of the sides being a yellow-brown; No. 3, sometimes nearly black, at others grey and silvery. The Indians positively assert that it is by no means unusual to see these three varieties of colour exhibited in different cubs of the same litter; and that the black and red varieties constantly interbreed I know to be a fact. I state this from my own actual observation of the animals when I was trapping and hunting on the eastern and western sides of the Rocky Mountains.

Of shy and crafty habits, few fur-bearing animals are more difficult to trap than foxes. The red men in North and North-West America employ a fall-trap for the capture of foxes, a trap requiring the greatest care both to bait and to set it. Each foot-print must be brushed over in order to destroy every trace of scent, and this obliteration is accomplished by the trapper as he walks backwards from the trap, using for the purpose a large broom, made of cedar boughs.

The bait, which is usually a skinned ruffed grouse or a rabbit, must not be touched with the fingers. Great care, therefore, is needed during the process of stripping off the skin. The "dead-fall," so called, is a heavy tree adjusted to tumble upon the animal's back just behind the shoulders, so soon as it unsets the trap. The "red trappers" have an idea that if a fur-bearing animal be not instantly killed the fur looses all its gloss. The same sort of idea is entertained by the metropolitan "white savages," who brutally skin unfortunate cats whilst they are alive. The inhuman monsters' pitiful excuse is, "if the cat was killed prior to its being flayed the fur would possess no gloss," hence the skin would lose much of its value. For reasons similar to the above North American savages seldom set steel traps for the capture of foxes, martens, or indeed any of the fur-bearers, the value of whose fur in great measure depends upon its silky and lustrous surface. The skins are stripped off in a peculiar manner, a small incision only being made betwixt the hind legs; the skins are turned with the fur-side inwards during the act of flaying, and they are then dried in the sun, stretched upon a piece of board carefully shaped for the purpose.

To my mind, the prettiest and sharpest fox caught for the sake of its fur is the kitt-fox, or swift fox (*Vulpes velox*), which

is a very much more appropriate name. The vast prairies, not unlike grassy oceans, over which the bisons roam in countless herds, east of the Rocky Mountains, are the favourite haunts of the kitt-fox. The little fellow can outrun the fleetest horse or dog, and even the long-legged and swift-footed greyhound-wolves fail to overtake it in a fair race across the rolling plain. As the trappers aptly say, "The kitt-fox goes like a ball from a rifle." As far as my own observations have been able to settle the question, I think I may safely say that the kitt-fox is entirely confined to the eastern side of the Rocky Mountains. There is not even any tradition, so far as I know, existing amongst the Red Indians concerning the existence of the kitt-fox west of the Rocky Mountain range; and, moreover, they do not even know the animal by name. I sought information from the Hudson's Bay Company's traders and the white trappers I from time to time met with, relative to their knowledge of the kitt-fox being known anywhere in our possessions westward of the Rocky Mountains; but in no case could I discover that the animal had either been seen or trapped. The number of kitt-fox skins sold in London annually, when compared with either red or grey fox skins, seems to be a very diminutive quantity, nevertheless, 8657 skins of the kitt-fox is about the yearly supply sent to our markets.

This quaint little fox differs entirely from all the other fur-bearing foxes. Firstly, we are amazed at its diminutive size when contrasted with its brethren. The extreme length of the kitt fox, measured from the tip of the nose to the root of the tail, does not exceed twenty-four inches; the tail is likewise remarkably short for a fox, being only from nine to ten inches from its junction with the body to the very extremity of its brush-like termination. The limbs are short, but strongly formed, which gives to the animal an appearance of being disproportionately long for its height. The toes are each armed with a claw, very much curved and always sharp, and during the winter months the soles of the feet are clothed with a perfect mat of hair—a good coating of hair invariably covers the lower part of the feet during the summer, but it is not nearly so thick and so dense as it is in the winter.

We can easily see the utility of this hairy kind of shoe or mocassin—it affords perfect protection to the fleshy "pads" whilst the animal is going at full speed over angular stones and rocks, or over that still sharper material, the "crust" upon the frozen snow.

The fur of the kitt-fox is close, soft, velvety, and very like dressed seal-fur to the touch. The head is remarkably short, and very broad between the ears, and the skull exhibits a very close analogy to that of the red fox, except that it is consider-

ably smaller. Professor Baird thus describes the skull of the kitt-fox:—"The upper outline is almost precisely the same as the red foxes, but perhaps more convex about the meatus. The temporal crests in seven skulls before me do not approach each other so much as in the red fox; the shape (lyre-form) and distance of the ridges more like what is seen in the grey fox, although otherwise this is a very different animal. The post-orbital processes of the frontal bone are rather short, and are more obtuse than in the red fox. The temporal fossæ are considerably larger in proportion, and the distance between the zygomata wider. The sides of the skull at the temples are considerably more convex. The forehead is rather flatter. The orbital process is further back. The lower jaw is very similar in shape to that of the red fox, although its lower outline is more curved."*

The dental formulæ differs very little from that of the red fox. The tail looks as if some person had shorn it, so short, and dense is the covering of fur; it is as round as a ruler, and terminates in a blunt tip, as if the end of it had been chopped off with an axe.

If different religious sects prevail among the foxes, the kitt-fox should assuredly belong to the "Society of Friends," always supposing we were to guess its creed from the style of its dress. No showy colours bedeck this tiny dweller upon the prairies, but clad from head to foot, in a suit of the soberest grey, it is in nothing conspicuous; neither has it anything to be proud of, save it be the quiet neatness of its exterior. The colour of the entire upper surface, together with the fore and hind legs, is a grizzly kind of grey, but this is overcast with a faint shade of brownish yellow; if the very thick fur be drawn apart with the fingers, or puffed open by blowing into it, it will be seen that the lower portion of the hairs are pale lead colour, whereas the tips are yellowish brown; whilst the longer hairs, interspersed amongst the fur, are of one uniform shade of brown to near the tip, which is reddish yellow, the shade usually designated "carroty" will best express my meaning. The under fur is pale yellow, but in old animals it becomes nearly white; a faint tinge of reddish brown overspreads the cheeks and lips, and extends nearly to the crown of the head. The colour of the tail, viewed from above, is precisely the same as that of the back, its inferior surface, however, is nearly white. The whisker hairs are unusually long and quite black. The kitt-fox more closely resembles the corsac fox (*Canis corsac*) than it does any of the North American foxes, the structural resemblance betwixt the skulls is very striking, and it is very difficult to discover

* "North Am. Mam.," p. 135.

any characters sufficiently defined to justify our making a separation specifically between the kitt-fox common to North America and the "corsac-fox," a native of Tartary.

The food of this singular fox is of the most varied character; sometimes it devours prairie-mice, and the smaller kinds of spermophiles; when luck befriends its efforts, a grouse is nabbed, and then the hunter feasts royally; but when times become disagreeably hard, and the larder is badly stocked or altogether empty, then in these straits grasshoppers and field crickets (*Acheta nigra*) are greedily devoured, and even old leather, or the hide of an animal, hair and all, comes not amiss, in the absence of more toothsome viands. The kitt-fox is a thief by nature and profession; hence anything, or I may say everything stealable, is most unscrupulously appropriated. Should you in an unguarded moment tether your horse with a lasso or hide "lariat," and a kitt-fox discovers your imprudence, you will most certainly find only the remnants of the tether; the horse which you expected to find safely fastened has gone you know not where. The robber, having gnawed the tether line in two parts, feasts himself upon that portion attached to the picket, or tree stump, to which you so carefully tied it.

If a hunter quits his camp in the morning, heedlessly leaving his mocassins or saddle, or food of any sort, within the reach of quadruped thieves, the first to discover it is pretty sure to be a prowling kitt-fox. Far from being content to dine respectably off tough mocassin or indigestible saddle, the glutton must needs taste everything he can find, with a reckless disregard to future consequences. A trapper is safe to pay dearly for thus carelessly leaving his camp, and returns to find his saddle with pieces bitten from out different parts of it, his mocassins minus toes, his bridle-reins nibbled into sundry pieces, the leather "possible sack" torn open, and its contents bestrewing the grass, and, to pile up the agony still higher, a dainty piece of buffalo meat that the hunter has probably been mentally grilling and eating during the homeward route, is borne off by the rascally kitt-fox. It is of little or no use to hide anything eatable, the kitt-foxes are sure to find it; the only safe plan is to place whatever you are desirous to keep upon a stage lashed securely to upright poles, and the stage must be at least six feet above the ground. I have often known kitt-foxes steal the bait from out a badly set fall-trap; and, moreover, they travel so swiftly and traverse such long distances when searching for food, that it is never safe to leave any articles within their reach, though you may feel quite confident that there is not a kitt-fox anywhere in the neighbourhood.

The female usually has young in the month of April, at the bottom of a deep hole, which she either excavates for herself, or she appropriates the abandoned residence of a badger or a marmot. The locality mostly chosen for the nursery is a steep earth-bank, beetling over a stream. The hole is dug in an oblique direction into the ground often to a depth of six feet. The number of cubs brought forth at a litter ranges from four to six, although the red men informed me that it was no unusual occurrence to find as many as eight. By exercising extreme caution, the woolly little family may occasionally be watched gambolling like so many kittens at the mouth of the hole, the slightest noise, even a stick snapping beneath your tread, sends them helter-skelter into the gloomy confines of their subterranean abode.

The grey fox (*Vulpes* (*urocyon*) *Virginianus*), so far as I know, is never found in Canada, but is extremely plentiful in the Northern and Southern States; it has been also found in Texas and Oregon. Some idea of the abundance of this fox may be learned by referring to the Catalogue of the March fur sales of 1866; 17,212 skins of the grey fox were then disposed of. The extreme length of the grey fox, exclusive of the tail, is about twenty-six inches, the tail measures about fourteen inches. I have previously described the curious mane-like arrangement of stiff hairs which grows along the upper surface of the tail. The grey fox is very distinct from the red fox, but it would not prove of any interest to the general reader were I to point out in detail the osteological differences, which undeniably prove that the red and grey foxes are specifically different. It is rather difficult to define the colour of the grey fox's fur, black, white, red, and brown, are so jumbled together, that it is next to impossible to convey by words what the shade actually is. Dark grey decidedly predominates along the line of the back, but at the nape of the neck it shades off into cinnamon yellow, which colour likewise tints the head, legs, and under parts. The tail is grey like the back, its inferior surface being a rusty kind of yellow. The hairs growing upon the back are about two inches in length, and some of them are quite black, whilst others are ringed with white from base to tip; the mane hairs extending along the tail are about three and a quarter inches long, and are generally of one uniform shade of colour, although annulated hairs are frequently observable. The short under fur is mostly of a yellowish brown colour.

I do not know a more wary animal than the grey fox; ever on the watch and sly to a proverb, it is by no means an easy beast to trap. Its fur is principally consumed in the manufacture of sleigh rugs, and for lining overcoats, cloaks, and

other descriptions of apparel usually worn by Continentalists during the winter months.

There yet remain two foxes that demand a passing notice, as being of some considerable importance to the furrier: the arctic fox (*Canis lagopus*), known commercially as the white fox, and the "blue" arctic fox.

It is very difficult to discover the actual number of white fox skins annually imported into this country from the arctic regions, but if we assume nine thousand as being somewhere about the average number, we shall not be very wide of the mark. I find, on referring to the catalogue of the collection of animal products in the South Kensington Museum, that the number of undressed fox skins imported in the year 1856 was as follows:—

From Hanse Towns	1,588
United States	44,126
British North America	35,598
Other parts	175
	81,487

From out of this heavy supply, 79,063 fox skins are re-exported to various cold countries. The chief demand for furs of this description is among the nations of Tartar and Slavonian extraction. I may instance the Russians, Poles, Chinese, Turks, and Persians. Then, again, we have another market amongst the people of Gothic origin, who occupy portions of the middle and western parts of Europe.

White fox skins are deservedly celebrated for their beauty, and the extreme fineness of their fur; neither have they the pungent, disagreeable odour that characterizes the skins of the other species of foxes. The price for white fox ranged, at the March sales of last year (1866), from 4s. the lowest price, up to 19s. 6d. the highest, which gives an average of 11s. 6d. per skin. As there were 7591 skins sold, the sum returned for white fox-skins would equal £4364 16s. 6d.

The arctic fox is principally found in the countries bordering the Frozen Ocean in both continents. It hardly needs any detailed description, because there are a great many specimens of this curious little animal in the Zoological Gardens in the Regent's Park, where five minutes' observation will do more to familiarize any person with its peculiarities than whole pages of description. As the cold and snows of winter approach, the coat of the arctic fox becomes exceedingly thick and ragged, and changes from blackish-brown, which is the summer colouration, to pure white. The winter jacket is therefore a most admirable protection; in the first place its thickness defies the extreme cold which prevails in high northern

latitudes, and, secondly, its whiteness helps to conceal the animal when traversing the snow.

In nearly every book on arctic travel the white fox is referred to, and its habits described. Pennant tells us "that in Spitzbergen and Greenland, where the ground is entirely frozen, they live in the clefts of rocks, two or three inhabiting the same hole. They swim well, and often cross from island to island in search of prey." The Greenlanders trap them either in pitfalls dug in the snow and baited with fish, or in an ingenious kind of spring trap constructed of "whalebone."

Sir John Richardson informs us that the arctic fox appears to be wanting in that extreme cunning for which reynard in general is so celebrated; "they will stand by whilst the trap is being prepared for them, and walk straight into it as soon as the hunter has left it."

It is an open question whether or not the "blue fox" is a species distinct from the white, or only a different condition of age; and as I am not prepared with any facts likely to settle the matter one way or the other, I shall not attempt to enter upon any discussion concerning it. There were only about ninety-two skins offered at the March sales, for the year 1866.

THE STRUCTURE OF THE ANNELIDS, WITH A CRITICISM ON QUATREFAGES.

By Edouard Claparede.

(*Continued from page* 273.)

Respiratory Apparatus.—"M. Quatrefages has actually made science retrograde in respect to the structure of the organs of respiration of Annelids. This is the weakest part of his book, alike in the introduction and in the generalizations concerning each family. The branchiæ have, according to the opinion of the honourable academician, a special structure, which permits them always to be distinguished. "These organs," he says, "are characterized by a single canal, to and from which the afferent and efferent vessels run. This canal, of which the walls are sometimes visible, and at others indistinct, is surrounded by a diahhanous substance, which appears to result from a thickening of the dermis. In this substance ampulla-shaped lacunæ are hollowed out, more or less developed, and always destitute of proper walls. The whole is surrounded by an epidermis extremely fine, and

not presenting any appreciable structure. . . . . At the close of a variable time the branchiæ contract, although no muscular fibres can be distinguished. The ampullæ empty themselves, and sometimes completely disappear. The blood runs by the central canal of the branchiæ, and arriving at the base of that organ, passes into the efferent vessel. In this return movement it necessarily meets with the venous blood, and must mix with a certain quantity of blood which has not been subjected to the action of air." Bearing in mind this radically false description, let us see how the normal circulation takes place in the branchiæ of an Annelid. There cannot ordinarily be any mixture of arterial and venous blood. In fact, the artery goes to the extremity of the branchia, where it turns upon itself to return as a vein. Vein and artery are exactly parallel to each other. Throughout the whole length of the branchia these two vessels are placed in communication by a double series of vascular loops, which pass into the subcuticular layer, and which offers the greatest facility for the action of water charged with oxygen, through the very thin cuticle. As for the contractility of the pretended ampullæ, there is nothing of the sort. Certain genera, like the Terebellians and Telethusians, for example, exhibit many rythmical contractions all through the branchia, but not of the vessels themselves. Moreover, this fact is exceptional. In the family of the Serpulæ only do the branchiæ exhibit even a remote resemblance to the description of M. de Quatrefages. In fact, in these Annelids the artery is continued directly into the vein at the base of the branchiæ, and from this point of reunion a single vessel proceeds, which penetrates the branchiæ, and sends a cæcum into each branchial branch. But M. Quatrefages describes in the secondary branches of the branchiæ of the Serpulians an apparatus of ampullæ, of which no trace exists. The blind-vessel exhibits no ramification, it is simply cylindrical and contractile, as described by Grübe and Kölliker. In their branchiæ, the blood exhibits an alternating movement, which is exceptional. In all the other families the branchial circulation is continuous in one direction. Blind vessels with alternating circulation, are found in the tentacles of Spiodians, Amphictenians, and Pherusians; in one part of the so-called branchial threads of Cirratulians, but these organs are not respiratory (unless, perhaps, lymphatic). [M. Claparède then remarks on the way in which M. Quatrefages was misled, and observes that the point was cleared up thirty years ago by Grube.]

"*Reproductive Apparatus.*—The reproductive apparatus of Annelids remains very imperfectly known. It is true numerous works have thrown fresh light upon the educatory

organs known, since Dr. Williams described them, under the name of segmentary organs; but our knowledge of the sexual glands has made little progress for the last thirty or forty years. This memoir will, I hope, make these organs, in a great number of species, sufficiently known."

M. Claparède then remarks on the very inexact description of M. Quatrefages, and continues:

"The distribution and conformation of the sexual glands of Annelids is subject to numerous variations, which will be illustrated by numerous examples in this memoir. The following may, however, be regarded as the most widely diffused. The sexual glands form more or less complex clusters or interlacements of cords, of which the axes are occupied by sanguiferous branches, often contractile. The sexual elements, when growing, form ruffs round the vascular axes, and develop at the expense of a layer of nuclei close to the vessel. With certain vesselless Annelids this form of sexual gland is preserved, but the axis is occupied by a solid cord, instead of a vessel. Among the females, the ovules are often in close juxtaposition in the ovary; sometimes, however (*Owenia*, Della Chiaje, and certain Polynoe), each one is inclosed in a special ovisac. In either case the eggs, on arriving at maturity, detach themselves from the ovary, either directly or indirectly, through rupture of the ovisac. The zoosperms detach themselves from the testicle to float freely in the perivisceral cavity. Doubtless this fundamental form is sometimes subjected to important modifications, to constitute, for example, the peculiar sexual tissue of the Nereidians, or the floating testicles of the Dasybranchians, which will be specially described. The egg-formation of the Terebellians and Serpulians is still more divergent, but we always find a cellular tissue, fixed, or composed of floating materials, in the midst of which the sexual elements are developed. . . .

"The sexual glands have long been recognized in many Annelids, but these old observations have been partly forgotten. Thus, while Pallas erroneously supposed the eggs of the Aproditians to originate in the liquid of the perivisceral cavity, Gott, R. Treviranus and Della Chiaje recognized the true ovaries at the base of the feet of these worms. . . . Even the existence of a sanguiferous vessel in the axis of the sexual glands was not unknown."

M. Claparède points out the errors of various authors, and adds:—

"It is indubitable that Annelids exist which are destitute of segmentary organs, or in which they are reduced to simple openings in the back of the body.

"*Nervous System.*—It is, without doubt, to M. Quatrefages

and M. Leydig that we owe the best researches into the nervous system of Annelids. The first chiefly directing his attention to the external form of this system, and the second to its histology. . . . M. Quatrefages has been so fortunate as to find a stomato-gastric system of nerves, similar to that of the Hirudinea. I have not been able to recognize it, but I am sure that a negative result is not of great importance in these difficult investigations. I am, however, astonished that the combined efforts of other observers have been equally unsuccessful. . . . The structure of the nervous system varies astonishingly in the series of Annelids; the distribution of nerve-cells particularly being subject to a host of variations, which will be explained hereafter. In the ventral chain the cells belong chiefly to the surface and the sides, as Leydig has already noticed. The existence of large tubular fibres on the dorsal surface of the nervous chain, so general among the Oligochæta, is confined among the Polychæta to a small number of families (Capitellians, Aricians, Spiodians, Syllidians, Eunicians), and even appear in some representatives only of these families.

The nerve terminations amongst the Annelids have only been studied hitherto by myself, and by MM. Keferstein and Kölliker. All these terminations appear related to the functions of touch. The nervous expansions of the organs of sight and hearing are little known, even in Alciope, notwithstanding the researches of Leydig. In reference to this subject, I may recal an opinion of Joh. Müller, which has fallen into oblivion. We owe to this great physiologist an excellent figure of the central nervous system, and of the eyes of the Nereids—a figure to which his successors have not added anything important. He does not consider the organ called a crystalline lens as a dioptric medium. He denies its transparency, and regards it only as a terminal enlargement of the optic nerve. Although the transparency of the crystalline body is in many cases incontestible, the opinion of Müller on the functional value of this organ should not be rejected. The eyes of Nereids and of most other Annelids appear destitute of all apparatus for accommodation. Admitting that the percipient elements are lodged between the granules of pigment, it could be only objects at a determinate distance that could project their images upon this choroid pigment, and the sight of the creature must be very limited. This difficulty disappears if we seek in the crystalline body at once a refractory medium and a percipient organ, as we are almost obliged to do in the crystalline cones of the Archropoda. . . . .

Restoration of Mutilated Parts.—The observations of Bonnet on the restoration of mutilated parts among the earth-

worms, confirmed by Lyonnet, Réaumur, Dugés, etc., were timidly questioned by Vandelius, and by Bosc, and more recently and positively by Williams, Vogt, and others. We must, therefore, be thankful to those who called attention to early observations, like Baird, or made fresh experiments, like Quatrefages.

The restoration of mutilated parts of Annelids is incontestible. Many of them can reproduce even the anterior region with the head. Amongst recent authors, M. de Quatrefages has demonstrated this fact over again in Eunice, and Dalyell followed step by step the reproduction of the head and branchiæ by the posterior extremity of a Sabella. I have also met several times with marine worms (Eteone, Nepthys, etc.) which have undoubtedly reproduced their anterior region, the restored portions being distinguished by lighter colour and smaller diameter. The aspect of these worms resembles that of the Heteronereids; so great is the difference in the two regions, one would think they were two portions of different worms stuck together. One interesting remark occurs with reference to this subject: If a worm is severed transversely, does the posterior part always reproduce exactly the number of segments in the suppressed anterior portion? It is probable. At least I met with an Eteone which reproduced an anterior portion of nearly fifty segments. The head is undoubtedly the first to be formed, and then fresh segments are successively produced at the junction of the old part and the new. This, however, requires to be supported by positive observations.

Geographical Distribution of Annelids.—In this section M. Claparède disputes the accuracy of M. Quatrefages in limiting the locality of species. M. Quatrefages does not admit, for example, that the Mediterranean and the ocean can be inhabited by the same species, and sometimes makes specific distinctions out of the fact of locality only. He also maintains that littoral species cannot live under such changes as the presence or absence of tides. At Naples, however, M. Claparède kept littoral Annelids for months in captivity, and found the best mode of making them prosper was to deprive them of water for some hours each day, in order that the vessel might be oxygenated.

Classification.—On this subject M. Claparède remarks that we are approaching a natural classification, and that the families now established are for the most part well founded. He does not propose any new families.

LUNAR DETAILS.—DOUBLE STARS.—CLUSTER AND NEBULÆ.—TRANSITS OF SATELLITES.—OCCULTATIONS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

Much of the story of *Copernicus* remained untold when we broke off last month, and what we have already heard may well give us an interest in the remainder. It will be matter of familiar observation how striking is its aspect under very varied angles of illumination—how the magnificence of its broad and massive wall, and the extraordinary roughness of its *glacis*, as it rises upon the terminator, give place to a relief in higher sunlight which exhibits the serpentine terraces, the central elevations, and the whole arrangement of the structure in a more intelligible manner; and how this aspect is again gradually replaced under increased illumination by one of more delicate but still very expressive relief, and of considerable permanency; I have seen a little true shadow cast from the great peak in the W. wall, and from a steep terrace on that side, as late as 3d. 1½h. before Full Moon. The beauty of these very dissimilar, yet intimately related aspects must be seen, and studied, to be fully appreciated. Mention ought to be made of a very striking engraving proceeding from the Collegio Romano,* as exhibiting the latter of these positions on a large scale, and with much cleverness of effect as well as fullness of detail, but, we are obliged to add, some degree of inattention also. We shall, however, proceed at present with an abstract of the remarks of B. and M. on its immediate vicinity. It is enclosed by a great mass of closely crowded mountain chains, arranged in lines partly radiating, partly parallel to the ring, especially on E. Here many of them are of very slight elevation (250 to 650 ft.), but on the opposite side they reach nearly 3000 ft. "Craters are first found at some distance, and but few in the mountains themselves, though those very obvious;" a great contrast, by the way, to the aspect of many other large cavities and their rings, as though the eruptive action had here more completely exhausted itself at one wide and unimpeded aperture. One is a small twin-crater (*Copernicus* A) on the S. slope, already seen by Schr., the larger orifice lying N., so deep that it holds its shadow longer than the great crater itself; its ring, of 6° light, is much more distinct from its interior of 3° than is usual in such little cavities; the small crater B, equidistant from the grand ring S.E., appears of similar depth. Towards the foot of the N.E. glacis, a larger opening, *Gay Lussac*, has broken through; this with its smaller

* Memoirs Roy. Astron. Society, XXXII. pl. viii.

companion, 4800 ft. deep according to Schr., was discovered by him, as well as a curious cleft running E.S.E. from it for some distance, which he compared to the great valley in the *Alps*, from the way in which its sloping sides are studded with small irregular hills, as though an upheaved and hollow ridge had fallen in, leaving the firmer portions hanging on its declivities. In the Roman drawing, the end next the crater is feathered out into oblique lateral fissures.

But the more remarkable features here are the great light-streaks which diverge from it in every direction. They form a less regular system of radiation than is to be found issuing from other centres, but still their relation to *Copernicus* as a departure point cannot be mistaken. Several of them connect this great crater with others in the neighbourhood which repeat the phænomenon, though on a smaller scale; in fact, but few large rings between the equator and 30° N. Lat. are wholly without them, and some exhibit them even beyond that limit. Near *Copernicus* they are merged in a bright but confused "nimbus," or glory, interrupted here and there by streaks and insulated patches of darkness, of which one is even found close to the wall. Further out they expand, and direct themselves partly in divergent, partly in parallel lines, to the neighbouring craters. Those pointing S. towards *Reinhold* (31) and *Gambart* (a crater between *Reinhold* and *Sömmering*—Int. Obs., xii. 218) are more feeble and ill-defined; they seem to indicate a fresh focus at *Reinhold*, but do not diverge from it again: those directed towards *Schröter* are more considerable, but do not reach the hill country; and here the aspect of the surface is rather that of dark streaks traversing brightness than the reverse. One such large dark streak passes from *Copernicus* A to *Stadius*, the S. quarter of which it includes, and then is lost. The darkest of these begin at a grey mountain marked ζ, and extend S.W. for 40 miles: the inquiry of B. and M. whether one or other of the unascertained spots of Riccioli is to be recognized here, must appear singular after a slight comparison of the old maps, which leave no doubt of identification as to his *Rhæticus*, though some regret at its not having been more accurately delineated in their great map. Towards *Eratosthenes* almost all the light is united in one mass, of which the brightness of the *Sinus Æstuum* may be considered a continuation. Further N. begin some very prominent streaks, few less than five miles broad, one leading to *Lambert* (35), 14 miles; some, which seem to start in the plain itself, are crossed obliquely by others coming from *Eratosthenes* the reverse way. Towards N. they are narrower and much interrupted; they are larger and more intense N.E. A great divided streak passes from *Mayer* (32)—a large crater N.E. of

Copernicus, with a smaller one on its W. edge—to *Euler* (36); others pass through the *Oceanus Procellarum* to meet the narrow and not easily distinguishable streaks of *Aristarchus* (43), and run into a great spot of light between both. Others, shorter and less distinct in appearance and direction, are found S. of *Mayer*. On the side of *Kepler* (41) they are more clear and decided: several, nearly parallel, run E. to that crater, and enter its "nimbus," thus uniting the two main streak-systems of the N. hemisphere. These details are so far worthy of record, as the suspicion of change in the reflective power of portions of the lunar surface, if not yet warranted, is not unreasonable. The streaks are of course best seen in Full Moon, very little of them being visible if the terminator has not passed *Mayer* in the increase, or reached *Eratosthenes* in the wane, and that little being masked by the opposite direction of the mountain ridges.

Copernicus and its nimbus can be clearly made out on the night-side before the First, not so readily after the Last Quarter.

We now come to a very singular region, more than once adverted to in our previous paper, and certainly in its own way one of the most remarkable in the Moon;—the *Crater-chains*, as we may term them, between *Copernicus* and *Eratosthenes*. Here we find the greatest and strangest contrast to the neighbouring *Sinus Æstuum*. There, craters are all but invisible, even after the strictest search: here they exist in such profusion that it is doubtful whether any really level surface intervenes. The sixty-one shown in the map, of which the greater part lie in a line between *Pytheas* (a moderate-sized crater two-thirds of the way from *Copernicus* to *Lambert*) and *Stadius*, are probably not the half that are perceptible, but past delineation. They are not scattered at random through the plain, but lie behind one another in rows, in some places closely compressed, in others wider apart at nearly equal distances, and but few seem entirely insulated. Though the majority are very minute, and only a few exceed 1″ in diameter, B. and M. cannot give them, like Gruithuisen, a width of only 500 (French) feet, but would estimate most of them at as many toises (3200 feet). The closely compressed rows, they observe, assume easily the aspect of a connected cleft; and, in fact, the two forms are nearly interchangeable; we only need imagine the absence of a common and usually very low partition, to convert the one into the other. At the N. end of the landscape, for the length of a lunar degree, there is such a cleft, with a distinct embankment on either side, and four of the smallest craters in its depth, with which the next three craters S. of it often seem to form a whole. At a distance of

20° at furthest from the terminator this crater-swarm becomes invisible, and the surface is then almost exactly similar in aspect to the *Sinus Æstuum* itself.

The discovery of this very singular region is due to Gruithuisen, 1815. He has well described its aspect, and speaks of the rows of craters as forming in places hollow ways, or being connected by a large longitudinal furrow, while the separate craters had outlets E. and W., which, however, are not visible if the illumination is precisely in that direction. And then he goes on, in his own way, to refer to the especial fertility indicated by the darkness of the soil; and considers them, if not volcanos, the artificial dwellings of living beings; in another place indicating his own choice between the alternatives by asserting that there is not a trace of a volcano, ancient or modern, upon the Moon! all its cavities having been formed by the impact of masses falling from space—of which portions still protrude as central hills! They are mentioned again by Kunowsky, 1821, who says that he often distinctly recognized, in clefts, rows of crater-like eruptions. Lohrmann's Sections and letterpress unfortunately do not include this region: his General Map indicates broad, low ridges, pierced with a moderate number of craters; but, though the first impression is not that of similarity to the Map of B. & M., a closer inspection shows that the objects represented must have been nearly the same. A corresponding view with that of Kunowsky is taken by Schmidt, who remarks that "everywhere a keen and unprejudiced course of observation will indicate that rills (clefts) are only crater-rows in a particular modification, as the innumerable transition-forms prove, and as Mädler first (?) pointed out." Little craters, he tells us, often lie in long lines, as if they had broken out of a crack, and he enumerates about 300 visible in the region now under discussion, many of which are contiguous, and frequently so confluent as to form ravines like regular clefts: their external height being, he thinks, very insignificant—somewhere between 150 and 600 feet.

Why these crater-chains were unnoticed by Schr. is a question which, though it seems to have been never asked, is deserving of an attempt at a reply. It so happens, indeed, that *Eratosthenes* and *Copernicus* were examined by him at different times, and represented in separate views; and that these miniature volcanos soon disappear after sunrise; and it may be admitted that he overlooked many small objects in various places. But, on the other hand, it must be borne in mind that his attention was evidently frequently directed to *Copernicus*; that the object, though fugitive, is in a very remarkable and conspicuous place, and is by no means collect-

ively minute, and that it would be distinctly visible in instruments having not more than a tenth or twentieth part of the power of those employed by him. If, therefore, we were to infer that this manifold outburst had taken place some time at the beginning of the present century, our argument would not want plausibility. It can, however, be only advanced with hesitation, especially in the face of such an authority as Schmidt, who asserted (previous to the much controverted discovery as to *Linné*) that no single region of the Moon had been sufficiently investigated, even with only a 5-ft. refractor, to admit of a satisfactory solution of the inquiry, whether eruptive action is still in progress. This, he then thought—a few years may probably show how far correctly—would require a special delineation and measurement of small areas little affected by libration, carried on for years with the most powerful instruments, and, if possible, under a sky such as the North of Europe does not afford.

It may, at any rate, be admitted that Selenography is not as yet sufficiently advanced to admit of our rejecting as wholly unserviceable any observations made with ordinary care and knowledge of the subject; and selection can only be practised among an accumulation of materials such as we do not hitherto possess. It is on this ground that I venture to bring forward a few extracts from my own note-books, which may be of some use for the purpose of comparison, or as awakening the curiosity or directing the attention of those who may be commencing lunar inquiries. We shall include the *Mare Vaporum* and *Eratosthenes* with our present position, in a very desultory and incomplete study of some of the aspects of this region.

"1831. April 20. Near *Eratosthenes*. The level plains and singular dusky tracts S. and S.W. of this crater, when carefully viewed, exhibited a peculiar stripy appearance, extremely like that of a cloudy sky; and the effect was quite that of local colour, not unequal surface, since the streaks made only an angle of 10° or 15° with the line of the cusps." The instrument employed was an ill-corrected fluid achromatic, on Barlow's principle, with an aperture of three inches, and power about 100.

1855, Oct. 18. The terminator passing through the *Sinus Æstuum*, this curious effect was again observed with a good $3\frac{7}{10}$-inch object-glass, as though a brushfull of dark but not evenly-mixed grey colour had been swept over the surface towards E. by S.—The following night, when $\frac{1}{4}$ of the ring of *Copernicus* was enlightened beyond the terminator, it was very evident and more extensive—"a vaporous or smoky appearance, drawn in stripes or thin parallel bands over most of the surface included between *Manilius* and *Copernicus*; its N. limit

being bounded by a line joining the centres of *Manilius* and *Eratosthenes*, its S. extending as far as *Schröter* (of B. and M.). The direction is about E. by S., and the streaks are parallel, and show no tendency to converge to *Copernicus*."—Oct. 20. The dark streakiness was "more intermixed with light stripes, which seem to be the streaks of *Copernicus*; in fact, the appearance, judging from to-night, may be due to the gradually-increasing visibility of those streaks coming up into sight with the higher illumination, through a smoky, brownish-grey surface. As observed last night, these streaks in the S. part of the surface in question do not point to the centre of *Copernicus*." Oct. 22, 4d. 2h. after First Quarter. "Dark streakiness seems now, in a very changed aspect, with great preponderance of light, to show an admixture in its S. portion of the streams of *Kepler* with those of *Copernicus*; the former seeming to pass by the S. side of the ring of *Copernicus*, and, of course, to be subsequently parallel to its streams. There is an evident crossing and interference of the two systems, as if they had not been contemporaneous, but the one had burst through the other." 1855, Dec. 29, 2d. 4h. before Last Quarter. *Mare Vaporum*: "the streakiness not remarkable, as in the increasing Moon."

1855, Oct. 19 (as before). Dark tracts near *Sinus Æstuum*. The equatorial region is "strikingly marked by three undefined spots of a brownish-grey of considerable extent, having a smoky aspect. The first is the slope of the *Apennines* S. of *Huygens*, especially where it borders the *Sinus Æstuum* by a gentle and slightly-elevated circular sweep; the second is apparently a rough surface of no great height, extending from Γ (B. and M.) N. of *Schröter* to the E. side of that crater; the third is a mass of low hillocks beneath the S.W. foot of *Copernicus*. Besides these, and divided from the second by a lighter surface, is a small dark tract, consisting, I believe, of two portions, and so represented by B. and M., N. of Γ (above)." These spots are all fairly traceable in the great map. 1867, Nov. 7. 9½-inch silvered reflector; terminator a little beyond *Gassendi* (64). The three dark spots of 1855, Oct. 19, very fairly made out, though illumination very much more advanced: the third seems to be the *Rhæticus* of Riccioli, very distinct and dark; but if the dark spot divided by a light streak S.W. of *Copernicus* in B. and M. is meant for this, as it appears, it is not well laid down; too small, and too far N. The "small dark tract of two portions" appears of a more complex form: the W., which is a pretty regular ellipse in B. and M. is now divided in half by a narrow brighter streak pointing S.W.—the E. is deeply indented from N.E. in the same direction by a broader and more obvious stream.

A continuation of these rough sketches must be deferred to another occasion.

DOUBLE STARS.

Before the constellation *Lyra* sinks too far towards the setting sun, we may point out some objects in it deserving of a search. The search itself, in a transparent sky, will sufficiently repay our trouble, for truly beautiful are the fields which, even with a small aperture, pass under review in sweeping over this district. We have long ago (INT. OBS. ii., 299, *et seqq.*) specified the principal double stars; we shall now add—

162. (Σ 2372). If we draw a line from γ through β, bend it slightly—about 25°—to the N, and carry it on fully 2°, it will strike upon this fine open pair. Σ makes them 6·7 and 8·2; white and bluish—I thought the latter pale purple. His other data are, 25″·147, 84°·23 (1829). Dawes's recent measures, 24″·75, 83°·57, very obligingly communicated to me, prove that the vicinity is merely optical. His acute vision detects a most minute point (12 mag. of Σ's scale) at a short distance.

A line carried the reverse way from β through γ, and similarly bent a little N, if carried a shorter distance than that between those stars, will fall upon—

163. 17 *Lyræ* (Σ 2461). 3″·6. 329°·9. 6 and 11. Light yellow and cerulean blue. This is called by Smyth very beautiful and delicate; and will be found a trying object for a small aperture. The companion is a minute point even with 5½ inches.

If we make the line joining *Wega* and γ one side of an equilateral triangle, the opposite angle will fall near two 5 mag. stars, η, n, and θ, s. Something more than 1° p the latter, a little s, is a 6 mag. star, 19 *Lyræ*; closely p which, a little n, lies a little quadruple group, of which the leading star is—

164. P. XIX. 13 *Lyræ* (Σ 2472, 2473.) 18″·5, 74″·8; the two nearest 5″. 337°, 350°; the same two 294°. 8, 11, 9½, 12. Bright yellow, pale grey, greenish, and dusky. The object is a singular and beautiful one, but its chief interest is the probability of variation in one of the two closer stars, which Sm. has recorded as very unequal, 1835·73, but which have been noticed by several modern observers as much less so, if at all. I remarked no difference, 1865·72. There is also a very minute star between the pairs not mentioned by him, though quite within reach of his instrument. The *lucida* seemed white to me.

If we make the line from β to γ the hypotenuse of a right-angled triangle, of which another side is directed from γ towards *Wega*, the right angle will fall nearly on a

little star, just visible with the naked eye. This will be our—

165. *Lyræ* 91 Bode. The telescope shows it as a wide but very beautiful pair, measured by Dawes at 45″·47. 350°·45, and Knott with almost an identical result. Argelander has given the magnitudes 7, 8·7, but has entered them collectively as 6 in his "Uranometria Nova."* I perceived, with $5\frac{1}{2}$ inches, two minute attendants, of which one is very small, perhaps Sm.'s 15 mag. The tints are in charming contrast; with $9\frac{1}{3}$ inches of silvered glass I thought them straw-colour and purple.

A similar object is to be found thus. If, instead of taking *β Cygni*, as usual, for the foot of the cross formed by the leading stars in that constellation, we make all the four arms equal, we shall be guided to a star to which the map of S.D.U.K. gives but 6 mag., but Argelander, 4.5. This is *η*. About 2° *of arc* (more, of course, of R.A.) *p* this, or more than 1° *n* of *χ*, a beautiful pair, our No. 59 (Int. Obs., ii. 304), we come upon—

166. P. xix. 278 *Cygni*, 39″.28°·8. 6 and 8 (Argelander, however, has not included it among naked-eye stars). Straw-colour and smalt-blue. H, with his usual predilection for ruddy hues, called it garnet and red. This and the last object are of the class of which *β Cygni* may be considered the type; either of them, however, appears to me, though far less brilliant, to surpass that celebrated pair in beauty of contrast, in consequence of the absence of any green tinge in the smaller star.

While referring to *β Cygni*, we may add another double star to our list from its neighbourhood. If we look for the only (telescopically) considerable star lying *nf* from it, we shall find the following delicate and beautiful object—

167. P. xix. 169 *Cygni*. 5″·8. 5°·2. 9 and 11. White and pale blue.

More directly *n* of *β* is a coarser pair, in a pretty "sprinkle" of stars. We may also mention that about ½° *s*, a little *f* from *a Cygni*, is a fine open pair, 8 and $8\frac{1}{2}$, white, followed by three stars of about the same magnitude, in a field finely dotted with minute points in the light of a $9\frac{1}{2}$-inch silvered mirror.

Observers who delight in star-colours will find it worth while to turn to *λ Lyræ*, 5.6 mag. (Argelander) closely *s f γ*. I have recorded it of a very fine yellow. A similar star (Y^2, that is, of the second degree of yellow in Smyth's notation)

* It is greatly to be regretted that the catalogue accompanying this accurate work which has received the high approval of so eminent an authority as Dawes, should be rendered extremely inconvenient in use by the want alike of an Index to the names of the constellations (under which it is arranged), and a corresponding heading to the pages.

will be found about 1° *p* γ *Cygni*, a little *n*. I noted it 7 mag. 1865, Sept. 22, but subsequently ascertained that, in the Larger Star Maps of the S.D.U.K., there is a 5 mag. star not far from its position, though rather more *n*. Argelander places a 6 mag. (166 Bode) much nearer my place. Is there room for a suspicion of variable light? There is also a 7 mag. star, solitary as regards rivals, though with a delicate 11 mag. attendant, pointed at by a line drawn from the 9½ mag. star in the group of ε *Lyræ*, through the southern of these two pairs, which shows a pale but evident carmine hue. It is registered as Bessel (Weisse) xviii. 1169.

An object of more signification than these is o^1 *Cygni*, the outlying member of the group o^2, described as No. 58 of our list (Int. Obs., ii. 304). The second and third stars of this fine combination were each described as *cærulea* by Struve, as far back as 1835; with the addition that all the colours were *insignes*, remarkable. He then expressly states that the blue stars maintained their tint whether the strong yellow *lucida* was in the field or not, so as to exclude the idea of contrast. In 1838 Smyth gave the same hues, and noted the same proof of independent colour. But in 1850 I entered the colours, with a $3\frac{7}{10}$-inch achromatic, deep yellow, white, and blue; and in 1865 I found, with 5½ inches, the 5½ mag. star, "white, or very pale yellow, with a sort of eye of blue, but certainly not at all like 7½" (the closer star) "which I found kept its colour when 4 was put out of the field. I had not at this time identified this as o^2 *Cygni*, and was quite ignorant of my former observation upon it." June 27, 1867, my 9½ inch "With" mirror showed them as strong orange, fine blue, and very pale yellow, or in Smyth's chromatic notation, O^{22}, B^8, Y^4, "the latter with a cast of blue, a strange but accurate description." The slight yellow tinge associated with reflection from these silver films would account for the deeper hue here ascribed to the great star; but not for the yellowish cast of the one in question, as fortunately it had been previously noticed with a very fine object-glass. It requires, however, to be noted by the way that those who possess these powerful instruments should look occasionally to the condition of the mirrors, especially the plane, or "flat," in such observations, as a slight degree of tarnish or cloudiness, such as may be expected to form from time to time, and may be readily and safely removed by gentle friction on a suitable rubber, would have a material influence on stellar hues. Were it not for the direct comparison with the unquestioned blue star at so short a distance, this might have been more lightly dismissed as a case of "chromatic personal equation;" but, under the circumstances, it seems to deserve more atten-

tion, as inferring the probability of actual change; and those who are interested in this curious subject will find this group well worthy of study. My own impression has the strong confirmation of Knott, who, in July, 1865, noted D (the star in question) "white, with pale dash of blue. D is certainly not so *blue* as C."

While speaking of coloured light, it may not be uninteresting to note the comparative absence of any decided hue in the larger stars of the Pleiades, as contrasted with many other parts of the sky, for instance, the galaxy region of *Sagitta*, where most of the leading stars show yellow, or ruddy light.

This opportunity should be taken for a careful study of the colours of the beautiful double star *a* Piscium (INT. OBS., iii., 55), as to which there is a remarkable discrepancy among astronomers. I have never been able to satisfy myself as to their real character.

The possession of the beautifully-figured 9½-inch "With" speculum, already alluded to, leads to the addition of the two following objects as tests for those who may be equally fortunate in optical means.

168. δ *Cygni* (Σ 2579), at the end of the *p* arm of the cross represented by the principal stars of that asterism. 1″·8. 25°·6. 3½ and 9. Pale yellow and sea-green. Such were Smyth's data for this celebrated but very difficult binary, 1842·56, which H saw 2″·5 apart, 1783·72, but single 1802, 1804, as did H. and South 1823, and South 1825. Σ, however, found it 1″·91, 1826·55; Smyth 1″·5, 1837·78; Dawes 1″·67, 1865·38; Knott 1″·7, 1866·68; while its orbital revolution has carried it through zero from the *nf* into the *np* quadrant, from H's 71°·39, 1783·72, by a regular gradation to Knott's 348°·31, 1866·68:—the "periastron" being considered to have occurred in 1860. This extremely difficult test I have seen so fairly with 450 in only a moderately favourable state of air, and at a comparatively low elevation, that it may be inferred to be easy under really advantageous circumstances; on the majority of nights it would, of course, be waste of time to look for it. The other object is

169. *μ Andromedæ*; the 4th mag. star next *np* β, in the line pointing upwards to the Great Nebula. This has a companion at 45″ and 115°, 16 mag., which is consequently as severe a test of light as the previous pair is of definition. It is so minute that Smyth saw it but once with his 5·9-inch object-glass, and when the larger star was hidden by a bar in the field.

This most delicate point I have caught up without much trouble, and that while, from a mistake as to the angle, I had so little expectation of seeing it where I found it, that I had

been diligently gazing at a spot 90° distant. It was but just steadily visible, but showed itself in the full presence of its blazing companion, so that it may be fairly inferred that this telescope reaches 17, at any rate, of the 20 magnitudes grasped by the 18-inch front view of H.'s metallic mirror. It may be mentioned that this speculum, which, however fine, can at any time be equalled, if not surpassed, by its truly successful maker, shows a black division, with 450, between the components of γ^1 *Andromedæ*, and, with a low power, traces for a long distance both of the remarkable "canals," or rifts, in the Great Nebula in the same constellation (INT. OBS., iv. 347).

While in this neighbourhood, we may look with a low power about $\frac{2}{4}$° f μ, where we shall find a deep orange single star, and a pretty open pair s of it, all of about 7 magnitude.

CLUSTER AND NEBULÆ.

46.—4575 Gen. Cat. (H viii. 56) is a charming group of stars of various sizes, to be found $\frac{1}{2}$° n of γ *Cygni*, a little f. H. saw it 5′ long, 3′ broad, and counted forty stars, two 7.8 mag., the rest 11 mag. In another observation he speaks of stragglers 10-16 mag.

47.—218 Gen. Cat. This curiously-placed and readily found nebula is in the field with β *Andromedæ*, a very strong yellow (Y^2) star; it lies at a short distance np, and is very easily seen in my reflector. H. calls it pretty bright, considerably large, gradually brighter in the middle.

A more singular object awaits us at no great distance, which we shall point out by the intersection of two straight lines, one drawn from γ *Andromedæ*, to γ (the central star) in *Cassiopea*, the other from β *Androm.*, to the glorious cluster in the Sword Hand of *Perseus:* near the point of their crossing are two 4 mag. stars, 2° apart; the further n of these is ϕ *Persei*, and 1° n of this is the nebula we are going to describe.

48.—385, 386 Gen. Cat. (M. 76). This is not a very conspicuous object with ordinary instruments, though it was "very bright" in H's reflectors; but its most remarkable feature is its double character, consisting evidently of two closely-connected lobes, and resembling a good deal the "Dumb-bell" in miniature, at least as that object was commonly figured before it came under more careful review. It has been examined by Huggins, with the following truly curious result:—"Both parts of this double nebula give a gaseous spectrum" (as is the case with the Dumb-bell nebula).

"The brightest only of the three lines usually present was *certainly* seen. The second line is probably also present. I suspected a faint continuous spectrum at the preceding edge of No. 386" (the *f* nebula).

TRANSITS OF JUPITER'S SATELLITES.

Dec. 4th. II. shadow in transit, 6h. 2m. to 8h. 51m. II. egress, 6h. 15m.—7th. I. ingress, 7h. 54m.—9th. I. shadow egress, 6h.—11th. II. ingress, 6h. 4m., shadow ditto, 8h. 39m. —16th. I. shadow in transit, 5h. 37m. to 7h. 56m. I. egress, 6h. 42m. IV. will be in transit while the planet is visible.—21st. III. shadow egress, 7h. 45m.—23rd. I. ingress, 6h. 21m., shadow, 7h. 33m.—28th. III. egress, 7h. 16m.— 29th. II. shadow egress, 6h. 1m.

OCCULTATIONS.

Dec. 8th. B.A.C. 830, 6 mag. 8h. 2m. to 8h. 10m.—9th. *f* Tauri, 4 mag. 3h. 18m. to 3h. 43m.—11th. 130 Tauri. 6 mag. 8h. 49m. to 9h. 24m.—13th. 5 Cancri, 6 mag. 11h, 29m. to 12h. 31m.—28th. B.A.C. 7097, 6 mag. 3h. 49m. to 4h. 49m.

TERMITES, OR WHITE ANTS, IN INDIA.

BY CAPT. R. C. BEAVAN, C.M.Z.S.

In a tropical climate like that of India, it is well known what numbers of destructive creatures, of all sorts and kinds, are rapidly generated in the warmth, and prove, more especially to the naturalist, a source of the greatest trouble and annoyance. Amongst the worst of these may perhaps be classed the Termites, or White Ants; and I propose to give a short account of what seems to be a beneficent provision of nature in the process by which at times they are nearly annihilated. Working in the dark as they do, and always hidden under cover, for they invariably form an exterior tunnel of mud under which to operate when they find it necessary to cross some hard substance that they cannot penetrate (such as iron, or the brick walls of one's house), it is not easy to imagine how they can possibly

be got at or destroyed by their natural enemies; nor, indeed, could they, were it not for the fact that, at a certain stage of existence, the majority of them are obliged to leave their secure underground retreats, and to take to the winged state. It is generally of a dry, calm evening,* frequently after rain, that from various crevices in the walls or stone flooring of the verandah myriads of unwinged white ants are seen to issue, as if forming both the escort and advanced guard of the grand army which, provided with wings, are about to follow. The toads, *Bufo melanostictus*, and frogs (*Sp. incog. nobis*) are on the look out for the former, and immediately congregate near the spot. Again and again is the tongue darted out, at every sweep clearing off several; and there they will stay and continue to feed, until their bloated appearance proclaims that they are full to repletion; when, suddenly, out come the winged host, which, rising with fluttering wings into the air, are met by birds and bats innumerable, and few escape. On the occasion referred to, we noticed the following birds of some twelve different species making sad havoc amongst the winged white ants which were rising from our verandah. Usually rather wild, on this occasion they were perfectly fearless and tame; and the perpetual snap-snap of their beaks whilst hovering in mid-air, and the sudden disappearance of every white ant that rose beyond a certain height from the ground, was a curious sight to see. The birds observed on this occasion were:—1st, the black-headed oriole, *Oriolus melanocephalus;* 2nd, the common king crow, *Dicrurus macrocercus;* 3rd, the tree-pie, *Dendrocita rufa;* 4th, the magpie robin, *Copsicus santaris;* 5th, actually a small owl not usually diurnal in its habits, *Athene Brahma;* 6th, the common babbler (or "seven brothers" of the natives, because they generally associate in that number), the *Malacocircus tericolor* of naturalists; 7th, the scarlet-vented bulbul, *Pycnonotus pygœus;* 8th, the common grey-necked crow, or jackdaw of India, *Corvus splendens;* and we think we also observed the green bee-eater, *Merops viridis;* whilst higher up in the air might be seen the common pariah kite, *Milvus govinda*, and the Brahmin kite, *Haliastur Indus*, swooping down on those unfortunates which escaped the birds at lower elevations. In addition to these may be mentioned the common Indian swift, *Cypselus affinis*, and, in fact, all birds which feed on insects would, we imagine, readily do the same. As it gets dark, the ants increase in number, and the birds, already filled to repletion, gradually go off to their roosting-places, and it seems as if they (the ants) were going to escape after all. But just at this moment another more terrible enemy makes

* The following notes were made at Barrackpore, on the 8th November, 1864.

its appearance. The air is suddenly filled with bats of all sizes; backwards and forwards they shoot without any intermission, and so eager are they in pursuit of their prey that we have frequently caught them in a butterfly net by simply holding it out from the top of the house. As may be imagined, these foes grant but little quarter, until the whole winged cloud of white ants is totally annihilated. Scarcely one has escaped to found a new colony; and, as night closes over the scene, they seem to be aware that wings are after all of little use.

Another note regarding them. We have frequently, of an evening, observed what seemed to be water-beetles in our tank and others in the neighbourhood. They kept spinning round and round like a Catherine-wheel, disturbing the water within a radius of fourteen inches. Occasionally one was taken down by a fish, or the species of skipping-frog, so ably described by Dr. Adams in his "Naturalist in India," page 16, would suddenly rush out from the bank, seize one, and devour it. Determined to secure one of these beetles, one evening, for our English correspondents, and being, moreover, rather puzzled as to why we only saw them spinning round of an *evening*, we made a capture, and, to our no small disgust, discovered that they were only winged white ants which had fallen into the water. The reason they are only seen of an evening is of course explained by the fact that white ants only come out in the winged state during that time.

LITERARY NOTICES.

THE DARWINIAN THEORY OF THE TRANSMUTATION OF SPECIES, EXAMINED BY A GRADUATE OF THE UNIVERSITY OF CAMBRIDGE. (Nisbet and Co).—Cambridge has not been successful with her "Graduate" who wrote this silly and impudent book. He has learnt nothing of the art of thinking, though he has made some progress in the trick of logic chopping, and in no part of his volume do we trace any symptom of his understanding the theory he undertakes to confute, and if, as we believe, he deserves to escape from the charge of wilful misrepresentation, his acquittal will be founded upon the evidence that he does not know enough of scientific facts and arguments to be competent to give an intelligible and accurate account of any important scientific work. His book begins with a statement purely and obviously erroneous, that "in Mr. Darwin's theory the idea of design in every form of organic life is steadfastly denied, and it is asserted that all existing plants and animals have been produced by slow changes, without any plan or intention, from some antecedent forms." This wrongheaded passage may perhaps be considered as tantamount to the assertion that there can be no plan or design in the creation of plants and animals subject to modification under fixed laws, for that is all that Darwinism implies. The "Graduate" is not original in this illogical notion, he has simply followed the practice of a class of persons who continue to find heresy in all science they do not understand, and who appeal—as the Graduate does—to what they term "common sense," as a convenient substitute for the accurate knowledge they have not the inclination or the capacity to acquire. Darwin's view on this subject is plain from the concluding remarks of his well-known work, in which, alluding to his theory, he says "there is a grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or one, and that while this planet has gone cycling on, according to the fixed law of gravity, from so simple a beginning, endless forms, most beautiful, and most wonderful, have been, and are being evolved." The theory of Darwin rests upon probabilities, which may be strengthened or overthrown, but whatever its ultimate fate in the belief of mankind, it does not touch the question of design or no design, in the manner supposed by the "Graduate," because no amount of action through secondary causation can render less probable the existence of a primary cause. On the contrary, if the operation of those forces, which are called secondary causes, can be shown to have led to harmonious and admirable results through long cycles of ages, the *quantity* of evidence in favour of plan and design is largely increased. An atheistic philosophy, no doubt, requires some physical theory of the production of organized beings, and it may, though not necessarily, adopt a scheme of development and hereditary succession with variation. If an animal sprang suddenly out of the earth, or were formed by a rapid concourse of atoms before our eyes, the spectacle, though contrary to experience, would not, in reality, be more won-

derful than the methods of production we are accustomed to by the development of a minute germ, nor could its appearance be a greater proof of design.

A good deal of the "Graduate's" logic chopping is devoted to an attempt at showing that Mr. Darwin admits the existence of species as *permanent* entities, while he is arguing against them. Quoting a plain passage, in which Mr. Darwin speaks of the more permanent varieties leading to sub-species, and species, he exclaims, "Well, then, *permanency* is, by Mr. Darwin's own showing, the attribute of species," although the passage in question contains no word to that effect, and the whole tenor of Mr. Darwin's book is to show that what are called species are subject to change. This shallow, flippant mode of treating a grave subject would have justified our taking no notice whatever of the "Graduate's" book, but although thoughtful arguments against Darwinism would be valuable contributions to a very difficult discussion, and would be welcomed by thinkers on both sides, it is time to put a stop to mere impertinence on such important themes.

In page 57 the "Graduate" gives a conspicuous instance of his habitual, though we have no doubt unintentional misrepresentation. Speaking of a well-developed tail—an organ he might possess with advantage, if it were prehensile enough to grasp an argument, or an idea—he exclaims "How formed? By natural selection, of course, for the theory allows no other *formative* power." Had he looked at, and been capable of understanding, a sentence in the "Origin of Species," 8th edit., p. 91, he would not have made this blunder, and probably would not have written his book.

At the place cited, Darwin says:—"Several writers have misapprehended, or objected to the term natural selection. Some have even imagined that natural selection *induces* variability, *whereas it implies only the preservation* of such variations as occur and are beneficial to the being under its condition of life." In page 115 the "Graduate" exclaims with that amusing self-confidence which crass ignorance permits to grow in egotistical minds, "Let, then, Mr. Darwin say what he likes, when animals cannot anywhere be discovered before a certain point in the geological series, it will be believed that their non-appearance is owing to their non-existence, and it will also be believed that when we first find them in a certain geological formation, that they then first began to exist. This is the opinion of a crowd of other geologists, and is the deduction of common sense"! These things will no doubt be "believed" by those who have been erroneously led to suppose that geologists have been able to examine a complete series of strata, corresponding with the successive groups of organized beings which have existed upon the earth. Students, however, who have had any opportunity of acquiring scientific knowledge on this subject, will be aware that the geological record, as at present known, consists only of imperfect fragments of a gigantic work, of which the missing chapters appear to have been much longer than those which have been recovered, and they will, instead of falling into the errors of the "Graduate,"

perceive that his "common sense" differs little from common ignorance, puffed up by uncommon conceit.

We could adduce many similar instances of the way in which the "Graduate" has attempted to fulfil his self-appointed task, but these will suffice, and if it should be our fortune to meet him again in print, we hope we shall find him in possession of a subject more adapted to his powers. Great workers in science, like Mr. Darwin, whether right or wrong in any particular hypothesis, are entitled to respectful treatment, and it is the duty of the press to protect them against unmannerly assault.

THE CABINET OF THE EARTH UNLOCKED. By Edward Steane Jackson, M.A., F.G.S., Second Master in the Tattenhall Preparatory School. (Jackson, Walford, and Co.)—This is a remarkably elegant little book; the very thing to coax young readers into a knowledge of elementary geology. The illustrations are unusually good; the landscape vignettes especially possessing great merit. We recommend this work to those who wish to make a pretty and useful present at a small cost; but in another edition we should advise Mr. Jackson not to dip his young folks in that sea of troubled waters, the reconcilement of Genesis and geology, and not to call the coral polyp an *insect*.

PHOTOGRAPHS OF EMINENT MEDICAL MEN OF ALL COUNTRIES, with brief Analytical Notices of their Works. Edited by Wm. Tindal Robertson, M.D., M.R.C.P., Physician to the General Hospital, Nottingham. The photographic portraits from life by Ernest Edwards, B.A., Cantab. No. 6, Vol. II. (Churchill).—The present number of this interesting series contains portraits and notices of the late Dr. Hodgkin, Dr. Cobbold, and Mr. Holmes Coote. This work merits the support of the scientific world.

HANDBOOK OF THE HISTORY OF PHILOSOPHY. By Dr. Albert Schwegler. Translated and Annotated by James Hutchinson Stirling, LL.D., author of the "Secret of Hegel," etc. (Edmonston and Douglas.)—Schwegler's work has been very popular in Germany. Its plan is to give brief notices of the various schools of philosophy, from the early Greeks down to Hegel. Dr. Stirling is anxious to counteract the positive school—Comte, Mill, Buckle, etc. In this he is not very happy, but his book will be very useful to students, and would have been more so if it had been printed in larger type. It is a mistake to put abstruse matter into very small print. Dr. Stirling coincides with Schwegler in making the history of philosophy terminate with Hegel, in which many will not agree. The merit of the book consists in the general clearness of its descriptions of various methods of thought.

RELIQUÆ AQUITANICÆ. Being Contributions to the Archæology and Palæontology of Périgord and the adjoining provinces of Southern France. By Edmund Lartet and Henry Christy. Edited by Thomas Rupert Jones, Professor of Geology, etc., Royal Military College, Sandhurst. Part IV. (Baillière.)—The fourth part of this splendid work contains very interesting matter, both in the text and in the elaborate illustrations. Two specimens of what are supposed, with probability, to have been stone mortars are figured. Objects of this

kind are found of various sizes; some large enough to grind small quantities of grain, while others of less dimensions may have been used for triturating articles on a smaller scale. They seem to have been made by hollowing out a depression in water-worn stones or pebbles. They are mostly of granite, but three or four of quartzite have been discovered, and one or two of sandstone. They are from two to eight inches in breadth, and are not polished. Numerous illustrations are also given of prehistoric art, in the shape of carved and sculptured bone, chiefly reindeer horn. The attempts to execute floral patterns are very roughly carried out, but much greater success attended the endeavours of the old Aquitainians to depict animals, as, even when the outlines are clumsy and incorrect, there is often a striking appreciation of the true character of the object. Thus in Plate VII. and VII. two awkwardly delineated horses are remarkable for a rude power of expressing motion, and the same may be observed in the two adjacent reindeer. Two fragments of dart heads are ornamented with very badly executed human arms and hands. Angular marks are sculptured on the arms, but it is impossible to say whether they represented tattooing or dress, or were merely fanciful lines of ornament. In another dart head we notice what the text calls a "bar-like ornament." It looks something like a leather strap or belt, with four holes at one end and three at the other. Most of the attempts at art are imitations of natural objects, but the slightly curved implement in B Plate X., with its row of oval figures touching each other, each oval having three furrows cut at one end, looks like an effort to make a conventional design, and cannot be complimented for its success. None of the ornamentation possesses a trace of humour, the grotesque probably being of much later date. In one case the stretched-out skin of some long-tailed animal has furnished the design.

Organic Philosophy. Vol. II. Outlines of Ontology, Eternal Forces, Laws and Principles. By Hugh Doherty, M.D. (Trübner and Co.)—When thoughtful works are written by men of considerable ability and attainments, they deserve a respectful treatment, and if a reviewer does not take the trouble to follow the author's lines of argument, and understand his results, he should abstain from hostile criticism. Now with regard to Dr. Doherty's ontology, we are in the condition supposed. We do not feel disposed to make a study of the work, because, from a cursory view of it, we do not think it would repay us for the labour. We cannot, therefore, pretend to do more than just glance at his philosophy. He classifies the sciences as methodological, cosmological, and ontological, and subdivides these into lesser groups. At the top of his methodological group stands biologics, comprehending physical biology, instinctual biology, mental biology, and spiritual biology; and at the bottom of this group we find physics, subdivided into photological physics and chemics, electrological physics and chemics, thermological physics and chemics, and barological physics and chemics. Below biologics he places sociologics, and between sociologics and mechanics stands "dialegmatics," comprehending musical sciences, linguistic sciences, dramatic sciences, and methodic sciences, the

three first being called "impartative" and the last "investigative" We may not be able to apprehend the ideas which are intended to be conveyed by these arrangements, but they do not seem founded on positive knowledge or fact, but rather to represent an arbitrary scheme in the author's mind. Perhaps our readers will derive some information from the following illustration of "transcendental philosophy." "An individual being is a miniature human world within a family, the family is a tiny world within a city, the city is a complex world within a nation, and a nation is a larger world within the limits of terrestrial humanity. Beyond the natural world of humanity we have the lymbic, beyond the lymbic the supernatural, and beyond all human worlds the superhuman."

GERMINAL MATTER AND THE CONTACT THEORY. An Essay on the Morbid Poisons, their Nature, Sources, Effects, Migrations, and the means of Limiting their Noxious Agency. By James Morris, M.D., Lond. Second Edition. (Churchill.)—A well-written and interesting little book, applying Lionel Beale's theory of germinal matter to the explanation of contagious disease. It is certainly exceedingly probable that such matter, in a minute state of division, brought into contact with appropriate materials in living bodies, is a common cause of disease; but the author throws little light on the question, as to the extent and circumstances under which physical or other conditions may occasion disease, without the actual importation into the system of an extraneous and living morbid particle. Nor does he afford fresh information as to the circumstances which enable some persons to resist contagious or infectious influences while others succumb to them. In spite of the best sanitary arrangements, particles of germinal matter, capable of inducing disease, are probably so widely diffused in large towns and their vicinity, that no one could expect to escape, unless the conditions under which they can operate mischievously were happily comparatively rare. The cattle plague doctors and the Privy Council recommended killing and burying every patient afflicted with the disease. Dr. Morris does not advise such treatment of bipeds, and does not enter into the question of its propriety with respect to quadrupeds. We cannot do wrong in following his advice to destroy germs of disease as far as possible; and the promulgation of the theory he espouses will be beneficial in suggesting useful action, and also in stimulating further research. With regard to the philosophy of the book, we may remark that a portion of "germinal matter" capable of independent existence, does not seem distinguishable from a "germ," and the diffusion of germs has long been recognized as a cause of disease.

THE MICROSCOPE, ITS HISTORY, CONSTRUCTION, AND APPLICATION; being a familiar introduction to the use of the Instrument and the study of Microscopic Science. By Jabez Hogg, F.L.S., F.R.M.S., Secretary Royal Microscopical Society, Member of the Royal College of Surgeons of England, author of "Elements of Natural Philosophy," a "Manual of Ophthalmic Surgery," etc. With upwards of five hundred engravings and coloured illustrations, by Tuffen West. Sixth Edition. (Routledge).—Without disparaging the

excellent works of other distinguished authors, to Mr. Jabez Hogg belongs the credit of having done the most for the popularization of microscopical science. In the preface to the present and sixth edition of his work, he justly observes that "a sale of fifty thousand is an unprecedented event for a work of this kind." Since the publication of his fifth edition, much light has been thrown upon various subjects then imperfectly understood, and some changes have taken place in power and apparatus. It was, therefore, necessary that a considerable portion of the matter in that edition should be modified or rewritten, and that entirely new subjects, such as the application of the spectroscope to the microscope, should be described. The present (sixth edition) will be found to contain a good deal more matter than the last, and it is enriched by eight beautifully coloured plates, which will add greatly to its popularity and value. It makes indeed so handsome and attractive a volume that it may well take its place amongst the gift-books of the season, and if accompanied by one of the numerous forms of microscope which it describes, it will supply intelligent families with a fund of instructive enjoyment. The average and deplorable ignorance of the upper and middle classes in this country on scientific matters, and the tendency to resort to frivolous amusements by way of killing time, is a painful fact against which our social reformers must struggle manfully, and although we do not wish to imitate the professors in the *Bourgeois Gentilhomme* in exaggerating the value of any particular pursuit, we feel amply justified in recommending the microscope as one of the most effective instruments for general instruction. To purchase a microscope with a few slides, and then to make unsuccessful efforts at the examining of common objects, is a process which has been tried hundreds of times with inevitable disappointment. To enjoy or appreciate the performance of a microscope, a considerable amount of scientific knowledge must be obtained. To manage the instrument well is impossible without some knowledge of optics: objects cannot be prepared, so as to be seen properly, without an acquaintance with their structure, and the acquisition of manipulative power. Vegetables and animals, either whole or in part, will afford little amusement without some acquaintance with, at least, the elements of physiology, natural history, botany, chemistry, etc. Thus the employment of the microscope may be made a constant stimulant to various studies, and any knowledge gained immediately repays the student by giving greater interest to old objects, or suggesting important points to be ascertained with regard to new ones. The task which Mr. Hogg has proposed to himself, and carried out with well-known skill, is to smooth over the difficulties which beset beginners, and he has achieved a high degree of success in the difficult art of combining the popular with the scientific. Many writers who undertake to be popular only twaddle about science, and their productions should be avoided as likely to mislead. Mr. Hogg adopts a strictly scientific method, but by avoiding the needless use of hard words, and by a good logical arrangement, he brings complicated subjects within the reach of ordinary intelligence and

reasonable attention. The first chapter of his work in its present state relates to the history of the invention and improvements of the microscope, and we may notice parenthetically that the publisher has unwisely placed the words "History of the Microscope" as the external title shown on the binding, thus misleading those who see no more as to the character of the book. The second and third chapters describe at length various instruments and apparatus, modes of preparing objects, etc.

The second part of the volume consists of six chapters, the first devoted to the vegetable kingdom, the second to the protozoa, and other forms up to the echinodermata, the third begins with the polyzoa, and ends with the annelida, the fourth relates to insects and spiders, the fifth deals with the microscopic structure of the vertebrata, and the sixth refers to crystals, polarization, spectrum analysis, etc., etc.

Although we recommend this work to intelligent *beginners*, it must not be supposed that it will not prove of service to more advanced students. It is indeed adapted to both—to the former from its simplicity and clearness, and to the latter from the care taken to bring each subject down to date. Thus the physiologist will find Mr. Whitney's elaborate and interesting researches into the respiratory apparatus of the tadpole fully explained and illustrated by a fine series of coloured drawings.

We feel bound to pronounce Mr. Hogg's sixth edition an honour to English microscopy, and we have no doubt we shall soon congratulate him on the appearance of a seventh, in which we recommend him to reconsider his reprint of the statement so commonly made about the highly composite character of the spider's thread. We pointed out last year that by placing an earwig in the web of the handsome garden spider, *Epeira diadema*, the use of the multiplicity of spinnets may be easily observed. The spider shoots out a sheaf of her silken threads, the ends of which stick to the earwig, which she then *pats* round and round, as if she were roasting him on a spit, until he is swathed like a mummy in the silken winding-sheet which the numerous spinnets enable her to form in a few seconds.

We must, however, while amply recognizing the merits of Mr. Hogg's book, protest against the injustice done to one of our great firms—Messrs. R. and J. Beck—whose numerous excellent forms of microscope are most unaccountably and unfairly omitted.

Introductory Text-Book of Geology. By David Page, LL.D., F.R.S.E., F.G.S. Seventh and Enlarged Edition. (Blackwood and Sons.) Advanced Text-Book of Geology, Descriptive and Industrial. By David Page, F.R.S.E., F.G.S., etc. Fourth Edition, revised and enlarged. (Blackwood and Sons.)—The second edition of Mr. Page's excellent "Introductory Text-Book" was published in 1855; the third in 1857; the fourth in 1860; the fifth in 1861; and the sixth in 1864, and now come the seventh in 1867. These simple facts testify to the great merit of the work as a simple intelligible introduction to a comprehensive and difficult science. We need only repeat the favourable opinion we have

before expressed of Mr. Page's labours, and add that his volume is well illustrated, and so low in price as to be within the reach of students of very small means—a fact which we consider important. Mr. Page's larger work made its first appearance in 1856, and the demand for a fourth edition, so soon as 1867, shows the well-deserved repute in which it is held. The present edition appears to notice all recent facts of importance. It is well printed and well illustrated.

PROGRESS OF INVENTION.

A New Hydraulic Cement.—Many excellent hydraulic cements are already known. A very simple and effective one has recently been added to the number by M. Lorel. It is merely a basic hydrated oxy-chloride of magnesium, and it is formed by adding a more or less concentrated solution of chloride of magnesium to magnesia. The magnesia may be very conveniently obtained by adding quick-lime to the mother liquor, that is the residue in salt works, which contains chiefly chloride of magnesium; magnesia will precipitate, and is to be calcined. Double chloride of calcium, and magnesium will remain in the liquid; and if chalk or lime are added, an excellent material for hardening common plaster on walls, etc., will be obtained; or the liquid itself may be used for moistening the materials in making the cement. Magnesiam cement is extremely plastic, and forms a substance like marble. It takes colour well, and it has such agglutinative power, that one part of it is capable of uniting twenty parts sand. It is, therefore, expected to constitute a means of rendering building easy, where building materials do not exist.

New Tubulated Syphon.—The common syphon, though made of glass, cannot it is obvious, be used with corrosive fluids without great inconvenience. A partial remedy, which consists of an accessory tube containing a bulb, has been long employed. The air is drawn by means of this tube from the lower end of the longer leg of the syphon: the necessary vacuum being thus made, the liquid ascends, and soon begins to flow. The bulb in the accessory tube with moderate care, almost prevents the danger of any of the liquid being drawn into the mouth. M. Zaliwski-Mikorski has, however, invented a syphon which is perfectly safe, and very simple; and in which blowing is substituted for suction. In his instrument, the accessory tube is attached to the lower extremity of the shorter leg of the syphon, and, on blowing into it, the liquid will be drawn up, and the syphon filled, provided the place of attachment is not too far from the liquid.

Printing on Glass.—Very cheap and beautiful products are now obtained by printing on glass; a large amount of the fine effect of stained glass being had for a very small portion of its cost. The inventor, M. De Mothay, uses for colouring matter pigments mixed with a solution of silicate, or silico-borate of potash and lead,

and a solution of resin in turpentine. The printing is effected with rollers, and the colours are vitrified by heat, no distortion taking place.

A NEW ANEMOMETER.—This self-registering instrument, the invention of M. Radan, consists of a pencil moving uniformly down a vertical cylinder, or from the centre to the circumference of a disc, on each of which paper has been placed. If the cylinder, or disc, is stationary, the line drawn on the paper placed on the cylinder will be perpendicular to the circumference of its base; and that on the paper placed on the disc will correspond with one of the radii of the disc. The pencil is connected with a Robinson anemometer in such a way that, when the cups have made a certain number of revolutions, it is lifted from the paper, an interruption being thus produced in the line drawn upon it. And the cylinder, or disc is made moveable on an axis, at the upper end of which is fixed an ordinary weathercock. The paper on the cylinder, or disc, is divided by lines into spaces which correspond with equal portions of time. The interruption, therefore, in the line made by the pencil, corresponding to a given time, will show the velocity of the wind during that time. And the deviations of the pencil-line from a round line will show its direction during any given time.

A NEW CANNON.—It is a matter of great importance that the force produced by the explosion shall be gradually communicated to the projectile. The inertia of the latter renders this necessary; since, though motion may be communicated very rapidly, it still requires a certain time for transmission. A powder may explode with such velocity, as that instead of the projectile being driven forward, the gun shall be burst; such would be the case were any fulminating compound substituted for gunpowder. Among the means used for securing a gradual communication of the explosive force to the ball is a cannon recently invented in America, and which is said to afford excellent results. Instead of the powder being accumulated in one chamber behind the ball, only a portion of it is placed there, the remainder being introduced into lateral chambers in front of the ball, and communicating by openings with the interior of the gun; when the powder has been placed in any one of these chambers, the opening which forms the communication between it and the exterior is closed by a screw. As soon as all have been charged, the piece is ready to be fired; and the instant the ball has passed the opening leading to one of these chambers the intensely heated gases following the ball, enter it, and exploding the powder which it contains, a new impulse is given to the projectile. This takes place after the latter passes each of the chambers; the explosive force of the powder being separated into successive portions and therefore rendered more effective. The explosion being divided there is less danger of the gun bursting; but the complication, and the time required for loading will be found more or less objectionable.

A SELF-REGISTERING MARINER'S COMPASS.—A mariner's compass which is capable of registering the ship's course, and is by no means complicated, has been invented by the Baron Webel-Jarlsberg, a Norwegian nobleman, connected with the marine. A time-piece, is placed

in the upper part of the binnacle, and is so constructed, that every two minutes it lets fall a very small leaden shot. This shot, falling on the moveable card of the compass, is conveyed by a channel to an aperture in the card, in which is fixed a small glass tube, and passing through this tube, it falls into some one of thirty-two radial compartments, into which a small box, which has been placed under the compass, is divided. As the box is immoveable, and the card is moveable, it depends on the course the ship is following, which compartment a given shot shall fall into; and the number of shots found in a given compartment, will show the length of time during which the vessel was steered in the direction corresponding to that division, since each shot answers to a space of two minutes. The contrivance is very ingenious, but, as at present arranged, it has certain defects: it does not tell exactly the length of time during which the vessel was steered in any direction: and at the end of a given period, only the sum of the times during which a given course was held, and not those times themselves can be ascertained. This, however, is not so inconvenient as might at first be supposed.

Simplification of the Galvanic Battery.—It has been found by M. Mannelli Giacomo, that sulphate of zinc may be substituted for the sulphate of copper in a Daniel's battery, without lessening the power of the battery. The effects of such a substitution is a considerable saving of expense, since the cost is merely that of the zinc consumed. He found also that a very good galvanic current will be produced, if zinc is substituted for the copper of the battery. In this case, the zinc constitutes both the electro positive and electro negative metal.

New Application of Gelatine.—The addition of glycerine to gelatine imparts to it new and valuable properties: the mixture solidifies on cooling, without ceasing to be ductile. Common glue mixed with one-fourth glycerine, becomes very similar in properties to caoutchouc, thus it will remove pencil marks from paper: it may, also be used as a varnish.

A New Photometer.—The transparency of the air on the approach of rains, so that distant mountains become more distinctly visible, has long been recognized as an almost certain prognostic of approaching rain. This transparency is usually considered to arise from the presence of watery vapour; but is said to be partially due to the rendering transparent, or precipitation of, organic matter. This is inferred from the fact that the air coming across arid deserts is transparent in dry weather, but the contrary in moist weather, when it has traversed tracts in which the heat rapidly and abundantly developes animal and vegetable life. In a moist atmosphere, the distant mountain is seen more clearly, because the watery vapour contained in the air either renders the germs of vegetables, etc., transparent, or makes them so heavy that they fall to the ground. And as the sanitary condition of the atmosphere is intimately connected with the presence of organic matters in it, an instrument capable of measuring the transparency of the air, and, therefore, of indirectly indicating the amount of organic matters which it contains, becomes of some importance. M. De La Rive has recently constructed an

instrument of this description. It is founded on the fact that the images of two objects, the rays from which traverse portions of air having different degrees of transparency, will be of different brightness; and that, if their brightness is equalized, the amount of adjustment necessary for the purpose will be a measure of the difference of the transparency of the two portions of air through which the rays from them respectively have passed. To secure accuracy of result, the two objects must be seen with the same eye, in the same general direction, and in the same conditions; and the light from other objects must be excluded. M. De La Rive's instrument consists of two tubes, having each an objective at one end, and their other ends attached to a common eye-glass, of which each objective takes up half the field. The optical axes of the two objectives form an angle which may vary from 0° to 29°, at the will of the observer. The rays passing along the principal axis of each objective are made parallel with the axis of the eye-glass by two rotal and successive reflections—the first from a moveable and the second from a fixed prism. The movement of the moveable prism is so connected with that of the moveable tube, that the angle described by the prism is half that described by the tube. Whatever the points towards which the tubes are directed, the images of these points are in juxtaposition in the focus of the eye-glass. The instrument is proved to be properly adjusted by turning it round through 180°, so that the objects are seen the first and second times through different tubes. The images obtained are equalized by the means used with ordinary photometers. This instrument will measure the comparative brightness of two stars, or of different portions of the heavens.

New Gauge for Steam Boilers.—One of the most frequent causes of steam-boiler explosions, is an insufficient water supply. This arises in some instances from neglect on the part of those in charge, but more usually from the difficulty of ascertaining the water level within the boiler. Many modes of automatic indication of a deficiency of water have been employed, and to a greater or less extent with advantage, but none are sufficiently effective to remove any possibility of accident. An American has, however, devised an apparatus for the purpose which is very simple, and appears to be very reliable. It consists in a tube fixed into the boiler a little below the proper water level, and projecting for some distance outwards, the internal extremity being open, and the outward closed. Around this tube is a casing, and the annular space between it and the tube is filled with water. As long as a proper water level is maintained in the boiler, the tube remains full of the fluid, but as soon as the water in the boiler falls below the opening of the tube, the latter becomes filled with steam or foam, and the water in the annular space around it boiling, steam is generated, and passes into a space prepared for it, where it blows a whistle, and even, if desirable, acts on a lever that opens the safety valve of the boiler and allows the escape of steam. Thus, not only is there notice of danger, but it is considerably diminished, until the proper measures are taken.

Undulating Railways.—The idea of an undulating railway is

not a new one: it has long since been proposed to utilise the force generated by descent down one incline for ascent up the next: so that some of the motive power required for propulsion of a train, should be obtained from gravity. An ingenious means of storing up the force of gravity so as to prevent the great variations of velocity which constitute one of the most serious objections to an undulating railway, is being experimented upon in Paris. The engine by which the motive power used for propulsion of the train is furnished, is provided with two heavy fly-wheels, capable of being made to work with or in opposition to the driving wheels. During descent, these fly-wheels, being made to revolve by the driving wheels, cause great retardation, and at the same time store up the power they have thus absorbed. Continuing to revolve with great velocity when it is necessary to ascend, they are so connected with the driving wheels that they cause them to revolve. The train is thus propelled, and at a practically uniform velocity, since from the large amount of matter the fly-wheels contain, they can lose a considerable amount of motion, without their velocity being greatly affected. Some motive power, independent of that obtained from gravity, would, of course, be required to supply the loss of that destroyed by friction, and the resistance of the air; but the amount must be inconsiderable.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.—*Nov.* 6.

Warrington Smyth, Esq., President, in the chair.

A. Tylor, Esq., F.L.S., etc., read a paper on the Amiens Gravel.

The author referred first to the prevalent views respecting the gravels of the Valley of the Somme, namely, (1) That there are two deposits of distinct age—the upper and the lower valley gravels; (2) That the former of these is the older; (3) That the Valley of the Somme has been excavated to the depth of forty or fifty feet since its deposition; (4) That both gravels contain bones of extinct animals, and implements of human manufacture, the lower gravels, however, containing the greater number of species of Mollusca, and the upper the greater number of flint implements; and (5) That the height (seventy feet) of the gravels of St. Acheul above the present level of the Somme is much beyond the limit of floods, and that, therefore, they could only have been deposited before the river channel was cut down to its present level. He then pointed out that the general effect of these views is to refer back the remains of man found at St. Acheul to an indefinite date separated from the historical period by an interval during which the valley was excavated.

In former papers Mr. Tylor stated his belief that the upper and lower valley-gravels of the Somme are continuous, and of

the same age, which he considered to be close to the historical period. In this paper he stated facts which appeared to him to demonstrate the truth of his views, and described a number of sections near Amiens, in which the levels were laid down from an exhaustive survey by M. Guillom, Chief Engineer of the Northern Railway of France.

The conclusions he had thus been able to arrive at are the following: (1) That the surface of the chalk in the Valley of the Somme had assumed its present form prior to the deposition of any of the gravel or loess now to be seen there; (2) That the whole of the Amiens valley-gravel is of one formation, of similar mineral character, contains nearly similar organic remains, and belongs to a date not much antecedent to the historical period; (3) That the gravel in the Valley of the Somme at Amiens is partly composed of débris brought down by the river Somme, and by the two rivers the Celle and the Arve, and partly of material from the higher grounds washed in by land floods; (4) That the Quaternary gravels of the Somme are not separated into two divisions by an escarpment of chalk parallel to the river, as has been stated; (5) That the evidence of river-floods extending to a height of at least eighty feet above the present level of the Somme is perfectly proved by the gradual slope and continuity of the gravels deposited by them; and (6) That many of the Quaternary deposits in all countries, clearly posterior to the formation of the valleys in which they lie, are of such great dimensions and elevation that they indicate a pluvial period just as clearly as the Northern Drift indicates a glacial. This pluvial period must have immediately preceded the true historical period.

ROYAL GEOGRAPHICAL SOCIETY.—*Nov.* 25.

Sir R. Murchison, President, in the Chair.

The following important letter relating to Dr. Livingstone was read, and it strongly encourages the hope that he is yet living, and may be continuing his journey with success. We present the letter entire, because our readers may have occasion to refer to it on future occasions, when fresh information arrives. In the course of the discussion which took place after the letter was read, additional reasons were suggested for accepting its evidence. If true, many months may elapse before the esteemed traveller, whose fate is an object of such profound interest, can make his way to any locality from which information can be transmitted.

"*Zanzibar, Sept.* 28, 1867.

"My dear Sir Roderick,—You know that a rumour has been current on the coast to the effect that a white man has been seen near Ujyl. Such a story came to us at a time when it was quite impossible that Livingstone could be the man. Now, however, another narrative has reached us, which, if we believe, it is, I think, difficult to avoid the conclusion that our distinguished traveller

may even yet succeed, and disprove the story given us of his death by the Johanna men.

"A Banian trader at Bagamayo told me three days ago that he had heard a rumour that some white man had been seen at Uemba; of this he seemed to have no doubt. To-day he brought a native whom he introduced and left alone with me. I entered into a conversation with him, and led him in an irregular way to give a general account of his journey, without guiding his imagination by any leading questions, determining to meet him again and fill in the details. When I had dismissed him, after my first conversation, it appeared that a ship would sail for Bombay immediately, and, not to lose a chance, Mr. Churchill, the consul, to whom I gave the notes, at once sent all to Bombay, and a request that the substance might be telegraphed to the Foreign Office—viz., that we had now some grounds for believing that a white man resembling Livingstone has been seen to the south of Ujyl.

"This native, with the rest of the caravan, left Bagamayo, and passed along the usual trade route to Uemba and Marunga, where they remained trading for some time, and again returned to the coast, where, in one of the villages under Marunga, which is a region governed by several chiefs, more or less dependent on one paramount, a white man arrived with a party of thirteen blacks, who spoke Supeli. All had firearms, and six carried double-barrelled guns. The white man was of moderate height, not stout, dressed in white, and wore a cloth wrapped round the head. He gave the chief a looking-glass, and was offered ivory, which he declined, stating that he was not a trader. He then went northwards. I do not know that this man can tell much more; he is a simple carrier who formed part of a caravan, but if we can find the head man of the party, it will be possible, no doubt, then to identify this stranger, who seems to our hopeful imagination so like our long lost friend; and then only think of the revelation he will have to make to us.

"It is decided that we go to Bagamayo in two days to make inquiries, but we must do so quietly. The story of a white man having been seen at Ilruwa, to the west of the lake, is a distinct thing from the more definite narrative we now have. But the one adds confirmation to the other, and shows that if it be Livingstone, in whose track we now are, that he has more than half finished his work, and is about to go to the Albert Nyanza. I may mention that there is now no doubt that the white man of whom I wrote formerly, long ago, as having been seen on one of the lakes by an Arab, and who remained on the coast, was a Turk, one of the traders who remained on the coast at Gondokoro, who have been met with in Uganda by Zanzibar merchants. The description fully satisfied me of this, and nothing is more probable. Thus the traders of Egypt and Zanzibar have now met in the interior of Africa. Speke's route has been quickly followed; how far this has been for the immediate benefit of Africa others may judge. In the end Africa will be overrun with traders in all directions, and then the vast resources of the continent will be shown.

"P.S.—Since writing the above I have again seen my informant, and placed before him my books of photographic portraits. In the first book he did not recognize the likeness of the man he saw in the interior, although it contained a very fine side view of Dr. Livingstone. In the second he at once pointed out a staring likeness of Livingstone, which I kept as a caricature, and said, 'That is the man. But,' he added, 'come to Bagamayo and see my master and the other men; they have seen him also, and will tell you all they know.'

"Suspend your opinion for a little, Mr. Churchill, and I go in two days to Bagamayo to make inquiries. Please communicate this view to Mr. Webb, Miss Livingstone, and other friends, but until my next maintain some caution.

"JOHN KIRK."

ROYAL MICROSCOPICAL SOCIETY.—*Nov.* 13.

James Glaisher, Esq., President, in the chair.

J. Gorham, Esq., read an interesting paper on a peculiar venation chiefly traceable in the leaves of certain compositæ, of which the marginal veins found in Eryngo offered an interesting specimen.

At the close of the regular business the meeting was made special to alter the bye-laws. In future, the entrance-fee will be £2 2s., and the annual subscription £2 2s. The composition fee for new fellows, £21.

NOTES AND MEMORANDA.

ROSS'S NEW FOUR-INCH OBJECTIVE.—Mr. Ross has very judiciously decided on meeting the demand of microscopists for a low-power object-glass, adapted to viewing large live objects, polyzoa, etc., and has produced a four-inch combination of great merit and utility. Many highly interesting objects—including anatomical preparations, entire insects, small star-fishes, sponges, corals, etc.—can be shown better with this glass than with any other we have seen. With the A eye-piece of Mr. Ross' series it takes in an object 7—16" in diameter, and the field is beautifully clear and flat. With deeper eye-pieces a higher magnification may be obtained, accompanied by much greater penetration than deeper objectives and lower eye-pieces will give, which is an immense advantage in many investigations. Mr. Ross has not hitherto, like Messrs. Beck, given his instruments enough rack-room for such low powers. He can, however, by a simple arrangement, accommodate the new glass in a perfectly satisfactory way. Every microscopist who sees the working of this four-inch glass will infallibly desire to be its possessor.

CHEAP COMPRESSORIUM AND SLIDE-CELLS.—At the suggestion of the Editor, Mr. Curteis (Mr. Baker's) has turned his attention to the manufacture of Compressoriums, which, while not pretending to all the convenience and accuracy of the most expensive kinds, will meet the average requirements of students at a

small price, and replace the clumsy and objectionable "live-box." In size and shape the Cheap Compressorium resembles two ordinary glass slides, one overlying the other. It is made of two pieces of brass—one carrying the cover, and the other the glass bed. It is raised by springs, and depressed by two screws easily worked. We have tried it with various objects, and can recommend it. As soon as an approximation to contact is obtained, the screws must be worked alternately, and very gently. Mr. Curteis' slide-cells are modifications of a plan introduced by Mr. Richard Beck. The cell is formed in an ordinary slide, with or without a back, according to its depth. The cover turns upon a pivot. They work well, provided the cover is quite free from grease; and this condition is easily obtained by washing it with a little caustic soda.

Day View of Venus with Small Telescope.—Mr. Lavander, of Canonbury, writes to us, that on the 20th of October, 2h. 50m., he saw Venus when only about 25m. 56s. east of the sun, and 9″·6 in diameter, with an inch and a half telescope, mounted equatorially by himself, and a power of about 90. A cloud obscured the sun at the time.

Test for Ozone.—During a recent discussion at the French Academy on the difficulties of Ozonoscopy, M. Le Verrier stated that, when the subject was discussed last May at Metz, M. Schönbein pointed out that a colourless solution of the protoxide of thallium became yellow under the influence of ozone, and was not, like the iodine test, affected by nitrous compounds; but, unfortunately, the subject was not yet brought to a practical state.

Free Sulphuric Acid in Molluscs.—In addition to the *Dolium galea*, MM. St. Lucea and Panceri inform the French Academy that they have discovered free sulphuric acid in the glands of *Tritonium corrugatum*, *T. cutaceum*, and *T. hirsutum*, *Cassis sulcosa*, *Cassidaria echinophora*, *Murex trunculus*, *M. brandaris*, *Aplysia cornatus*, and others (not named). They observe—"Free sulphuric acid is thus found to be an element necessary to the organic functions of a numerous class of mollusks, living in stony localities, and carrying a shell formed almost exclusively of carbonate of lime, accompanied by traces of carbonate of magnesia. The strong acid is found in company with a weak acid—carbonic."

Electricity and Vegetation.—M. Ch. Blondeau states ("Comptes Rendus," Nov. 4, 1867), that subjecting fruits—apples, pears, and peaches—to the action of an induced electric current hastens their maturity. Having rendered seeds good conductors by moistening them, he affirms that electrizing them by induced currents causes them to germinate earlier than similar seeds not subjected to such action. He says, "Some haricot beans which were electrized exhibited a singular peculiarity. They germinated head downwards, and root upwards, in the air. That is to say, the gemmule, surrounded by its cotyledons, remained in the ground, while the root, separated by a little stem from the gemmule, erected itself in the air. This fact appears important, as explaining the reason why plants push their roots into the earth, and their stems into the air. This tendency is so strong, that efforts to cause them to act otherwise are fruitless; but it may be overcome by the electric shock, in the same way as the poles of a magnet may be reversed. We are tempted to liken the embryo to a small magnet with opposite poles."

Hybrid Cotton.—M. J. E. Balsamo states ("Comptes Rendus") that, by artificial fecundation, he succeeded in obtaining hybrids between the Nankin cotton-plant and the *Gossypium barbadense*, and *vice versâ*. In both cases the cotton obtained was of a character intermediate between the two types.

Light and Vegetation.—The same observer planted cotton-seeds in a glass vessel at various depths of garden mould, and in contact with the glass side. Some were protected by yellow paper gummed to the glass, and others left exposed to the light. The former began to grow in nine days, while the latter were found to be slightly decayed at the end of ten days.

New Mud-fish from New Zealand.—In "Annals Nat. Hist." for November Dr. Günther describes a new mud-fish sent to the British Museum by direction of Sir G. Grey. It is about 5½ inches long, possesses the general characters of Galaxias—scaleless fresh-water fishes, of which five out of twelve known species belong to New Zealand, New South Wales having three, and Van Dieman's Land

two. "Eastwards the same genus is met again in the southernmost parts of America (Falkland Islands, Patagonia, Terra del Fuego), and a minute form occurs in Chili." Dr. Günther names the new fish *Neochasa apoda*. It has a broad, obtusely-rounded snout, mouth-cleft moderately wide, the maxillary extending below the eye, which is very small. Anterior nostril prolonged into a minute tube; several wide pores at the upper part of the head. A rather deep groove from the head along the middle of the back and abdomen. Dorsal and anal fins about as high as the tail between them, and both continuous at the base with the rudimentary rays of caudal fin. Caudal fin rounded, as long as head without snout; pectoral somewhat shorter. Brown, with irregular, blackish, transverse spots. Dr. Hector states that it was found four feet from the surface, in a stiff clay, embedding roots of trees, in a locality thirty-seven feet above the Hokitika River, three miles from the sea, which was at one time a backwater of the river during floods. Two years ago it was a swamp, but the miners pierced through the clay to a bed of gravel, and drained it. Dr. Hector adds, "Mr. Schaw, the Warden of the District, has examined seven or eight specimens of this fish, and assures me they occur in hollows of the clay, and that although when first extracted they moved freely, if placed in water they get sluggish, and soon die." He further states that the early settlers in Zealand were frequently astonished at digging up fish as well as potatoes. All these fish are very fat, and Dr. Günther found this one quite greasy.

The Newton Forgeries.—There seems now every reason to believe that the extraordinary mass of forged correspondence in the possession of M. Chasles, and which he has defended with such remarkable and ill-judged pertinacity, was fabricated by Desmaiseau between the years 1732 and 1745. He was a collector and dealer in autographs. Sir. D. Brewster says that the "celebrated deist, Anthony Collins, the friend of Locke, left him his MSS. to be published after his death; but he sold them for fifty pounds to Mrs. Collins, by whom it appears they were destroyed." Internal evidence at once showed that Sir Isaac Newton could not have written the letters ascribed to him; and the more the correspondence has been examined, the stronger has been the proof that the whole collection was fictitious.

Electro-capillary Currents in Plants.—M. Becquerel elucidates this subject in "Comptes Rendus." He says that he makes a transverse section of the stem of a young poplar, oak, or maple in full sap, and introduces two non-polarized platina needles, in connection with a very sensitive galvanometer—one in contact with the central pith, and the other with one of the ligneous layers. An electric current is immediately manifest, and by its direction indicates that the pith is always positive, relative to the other parts. The maximum of effect is produced when the second needle is placed between the woody layer and the bark. The positive condition of the layers augments towards the pith. From this state of things it follows that the liquid which moistens the pith, and the cellular tissue in general, is more oxygenated than what is found in other parts of the plant. In leaves the cellular tissue is positive, with relation to other parts. The earth is found positive in relation to the roots of plants, and their stem and leaves; that is to say, in relation to the liquids which moisten them.

The Walrus at the Zoological Gardens.—We recommend all our readers who have not already done so to go and see the young walrus at the Zoological Gardens. He answers to the name of "Jemmy," and seems both tame and good-natured. He has improved much in appearance since his arrival, and thrives upon a diet of fish and porridge. A few days ago Mr. F. Buckland tried to tempt him with some shrimps, as "Land and Water" tells us, but he did not condescend to eat them, though fond of whelks and mussels. He does not walk as well as the sea-bear, nor manifest as much agility; but he is only a youngster, and has not had much pains taken with his education. He is now in the large pond with the seals.

FRESH-WATER PLANARIÆ.